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EDITORIAL

JOHN EVELYN: FORESTER EXTRAORDINARY

ALL the older professions and sciences have established historical backgrounds. Members of such professions and scientific groups are intensely proud of the achievements of their great and near-great. Who among the physicists, for example, does not know of Archimedes, of Galileo, of Sir Isaac Newton, of James Clerk-Maxwell, of Sir William Thompson, of Count Volta, of Michael Faraday, and of J. J. Thompson? Who among the plant pathologists does not know of Fabricius, of De Bary, of Kűhn, of O. Brefeld, of Robert Koch, of the Tulasne brothers, of Sorauer, of Marshall Ward, and of E. F. Smith? Who in medicine does not know of Hippocrates, of Paré, of William Harvey, of Edward Jenner, of O. W. Holmes, of Pasteur, and of Sir William Osler? What chemist does not know of Lavoisier, of Sir Humphrey Davy, of Dalton, of Mendeléef, of Liebig, of Wőhler, of Kekulé, and of Mosley?

Why should not foresters be equally familiar and take equal pride in the achievements of John Evelyn, of Zanthier, of Georg Ludwig Hartig, of Cotta, of Hundeshagen, of Heyer, of Duhamel, of Lorentz, of Huffel, of Schlich, of John C. Brown, and of many others? It may well be that not all these men compare in intellectual stature with the great chemists, physicists, physicians, or botanists. Nevertheless, it is certain that they have made scientific or professional contributions of no small import. Still more certain is it that some of these names would be included in any list of outstanding scientists and technicians of the past. Most certain is it that John Evelyn, because of the breadth of his scholarship, his wide interests and achievements in many fields of learning, must be regarded as a truly great man.

John Evelyn is probably best known as a diarist. He might also well be considered an historian. If occasion should so demand, John Evelyn might be classed as a political leader of his time, or as a Greek scholar, or better still, a traveler. In fact, John Evelyn is difficult to classify. Foresters should regard him as a forester.

John Evelyn was the second son and the fourth child of Richard Evelyn and his wife Eleanor. He was born in Watton, England, on October 31, 1620. From the age of eleven onward and down to the month of his death, he kept a diary, as did his father before him. Because of this diary the record of Evelyn's life, despite its fullness and complexity, is unusually complete.

Foresters may legitimately lay claim to Evelyn as a forester because of his book *Sylva or A Discourse of Forest Trees*, published in 1664. *Sylva* is undoubtedly one, if not the greatest, of Evelyn's literary works. Few if any men or books so profoundly influenced the course of forestry in any country as John Evelyn and his *Sylva* influenced the course of forestry in England. In order fully to appreciate the significance of Evelyn's contribution to English forestry, it is necessary to consider briefly the forest history of England.

There is considerable evidence for the belief that originally the greater part of the British Isles was covered by extensive forests. Even at the time of the Roman invasion, they were for the most part covered. As the population increased, there was a corresponding increase in agricultural acreage at the expense of the forest area. The destruction of the forest would have been still greater and more complete had it not

been for the fact that large forest areas were reserved for the king and his nobles for the chase. During the reign of Edward I, however, the area of royal forest land was greatly reduced to provide additional agricultural land because the plight of the rural population had become unbearable.

By 1482 the government had become very apprehensive because the rapid rate at which the forests were disappearing threatened an adequate supply of oak naval timber. Through various statutes the forest area and timber supply of the country were increased, only to be largely destroyed during the reign of Henry VIII and during the Civil War. Between 1642 and the Restoration, the situation had become critical enough to cause general alarm.

About this time Evelyn and his friend Robert Boyle became interested in founding a philosophical and mathematical society, which did not materialize because of the Restoration. A little later, however, these same men were among the most prominent of the founders of the Royal Society. At least three or four times during his life Evelyn was asked to accept the presidency of that society, but on each occasion he declined.

On October 15, 1662, Evelyn records in his diary that "I this day deliver'd my 'Discourse concerning Forest Trees' to the society, on occasion of certain queries sent to us by the Commissioner of his Majesties Navy, being first booke that was printed by order of the society, and their printer, since it was a corporation." It should be a source of no little gratification to foresters that apparently the first publication authorized by the most distinguished scientific society in the world dealt with the subject of forestry.

Evelyn's *Sylva* is truly a significant book. It was published under the auspices of a society which even in those days was great; it was dedicated to the King; it was timely; and it espoused a worthy cause. That it bore fruit is evidenced by the fact that four years after its publication Evelyn was able to report to his King that "millions of trees had been planted."

Space does not permit considering even a small part of John Evelyn's accomplishments. Had Evelyn been a physicist, as his friend and contemporary Robert Boyle, his name would be as hallowed among physicists as is that of Boyle. Had he been a physician, his name would still be as well known among physicians as is that of William Harvey, who also was a friend and contemporary of John Evelyn. But in a very real sense John Evelyn was a forester —self-taught, to be sure—and unfortunately his name is all but forgotten among the rank and file of foresters.

The statement is often made that forestry has become of age. In a physical and economic sense this is perhaps true. In a spiritual and intellectual sense it is not so evident. Forestry will never become of age intellectually until the great names in forestry are as well known and highly respected among foresters as the great names in other fields of learning are known and respected in those fields of learning. Foresters must grow in intellectual stature. They must develop and establish the historical background not only of the science but of the practice of forestry. As a beginning, let us claim John Evelyn as a forester, despite the fact that others may also lay claim on him. By so doing we will add greatly to the dignity and prestige of our profession.

EXTENDING PUBLIC CONTROL AND MANAGEMENT OF FOREST LAND WITHOUT PURCHASE[1]

By CONRAD H. HAMMAR[2]
University of Missouri

A far greater area of forest land needs to be brought under management. Extension of private management proceeds only very slowly and extending public control and management by purchase will run to great expense. The plan herein offered proposes that government purchase control rather than ownership of forest land. Present holders of timberland would continue their ownership but would grant the government an easement permitting it to control and develop the timber. Income from the sale of timber would be shared upon a predetermined basis. Local governments would receive a subsidy in lieu of taxes. Costs of acquiring control are much less than those of obtaining outright possession and the savings to government would, therefore, be considerable.

PRESENT day techniques of extending control and management to lands needing reforestation in the United States are still inadequate. Only 30 percent of the forest land areas in the United States is under public control, and only a minute fraction of the 70 percent still in private ownership is under adequate management, according to the recently issued annual report of F. A. Silcox, United States Forester. The pressing problem of forest restoration remains the need to extend management and control to the 70 percent of forest land still owned by individuals.

Considering the great need to bring this huge unmanaged acreage under control, there is an unquestionable temptation to use autocratic methods to force reluctant owners into line, on the one hand, or to extract huge sums from the state legislatures or the federal government for purchase as a preliminary to the extension of control, on the other. With respect to the first temptation, Mr. Silcox in his annual report says, "Before applying public regulations to private lands, we should establish such things as local representation, and appeals; so adapt it to the institutions and traditions of our country that it will be entirely within the pattern of true democracy."[3] With respect to the temptation to blanket our forest areas with public ownership, the condition of the federal and of the various state budgets after a long siege of relief expenses during and after the depression is answer enough. The conclusion is that some means must be found for public and private cooperation in the management of forest lands now unmanaged. This cooperation must, furthermore, be attained without the use of autocratic methods, or the need for public purchase.

The Situation in Missouri

The author is most directly interested in the State of Missouri where a smaller replica of the situation in the country as whole exists. In Missouri with an admitted 15,500,000 acres needing management only 3,300,000 acres are in national forest purchase units, and only a 1,000,000 acres have been purchased to date. The state owns a negligible acreage and private owners so far make virtually no attempts at management. In other words, management and control have been established on less than 20 percent of the lands needing it, and the means of providing it for the remaining 12,000,000 acres are not in sight.

The reasons why public control and management are not extended immediately to the remaining 12,000,000 acres in Missouri rests, under present circumstances, almost wholly in the fact that neither the federal nor state governments are willing to provide sufficient money for purchase and subsequent management. There are indeed some difficulties that have arisen in connection with public ownership of forest lands in the Ozarks, and these would be

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[1]Contribution from the Department of Agricultural Economics, Missouri Agricultural Experiment Station, Journal Series Paper No. 564.

[2]A number of persons have generously aided the author by critically examining the plan he has proposed and giving to him a number of constructive suggestions. These persons include John H. Dickerson and John Timmons, Student Assistants; Prof. B. H. Frame of the Department of Agricultural Economics; M. C. Williams and R. J. Silkett of the Farm Security Administration.

[3]See Discussion of Report in *New York Times*, Jan. 3, 1938.

accentuated by its further extension.[4] Public ownership depletes the already critically low tax base of the governmental units in the forested areas without providing adequately for reimbursement of these governments for the loss they suffer. The now traditional 25 and 10 percent of gross receipts returned to local governments is by no means an adequate provision since the gross receipts will be negligible for 25 years. These governments cannot exist unaided for so long a period. They are at present overwhelmed with tax delinquency, unpaid and protested warrants, and a high level of public debt.

Our Changed Conservation Program

Perhaps the remark is justified that, now that the Forest Service is extending its conservation program to the forest lands in the eastern as contrasted to the western forest areas, the new lands acquired will be increasingly in communities faced with fiscal and economic conditions similar to those that characterize the Missouri Ozark counties.

One should note also that since the advent of the present Roosevelt administration, and particularly since the publication of the Copeland Report both the official and popular attitude toward forest restoration has changed. Prior to 1933, the attitude toward the need for vigorous restoration was greatly influenced by the unwillingness of government to compete with private forestry. The program of purchase was therefore one of buying up relatively petty acreages here and there, coupling this with an unconvincing effort to educate private persons to inaugurate management policies. There appears now to be widespread recognition, not only in Washington but in the states as well, that it would be worth while to extend control and management to the entire forest area. The December 1st report of the National Resources Board, for instance, recommends the extension of forest management to 615,000,000 acres, 359,000,000 acres to be in public ownership, and 257,000,000 acres of this to be owned by the federal government. Under the program of acquisition that has been followed in recent years it would require a century to attain this goal for public ownership.

[4]See pp. 79-97 in Mo. Agric. Exp. Sta. Bull. No. 392, for a discussion of these problems.

The Proposal in Brief

The inadequacies of the public purchase programs and the difficulties involved in extending them in eastern sections, do not, however, make any less pressing the need for extending both control and management to lands now without them. A method of combining public control with private ownership is here proposed in the hopes of avoiding some of the difficulties involved in public purchase. The method in general calls for continued private ownership under easement with control contracts granted to either federal or state governments, or a combination of these two. The elements of the plan are these:

(1) Private persons would continue to own the land and would receive at the harvest period a return upon investment in the form of a percentage of the timber harvested.

(2) The government would undertake the management, development, and control of the lands and would pay to local governments a calculated return in lieu of taxes: these payments to begin immediately or at the nearest date of tax collection after the control contract is executed and to continue indefinitely.

(3) Private individuals would be relieved of all responsibilities with respect to their land though they would remain its nominal owners. The proposal in short is that the government restrict its program to one of acquiring only those rights needed to establish an adequate system of control over the lands needing reforestation, and that it give up, at least for the most part, its present program of obtaining all rights by purchase and ownership.

Federal government, local government, and private owner of the land would all participate in income. These participants would divide the yield of timber on some predetermined basis. Thus in a typical instance: 25 percent of the timber yield might go to the private owner, an equivalent of 25 percent to the local government, and 50 percent to the federal (or state) government (or both) to defray the costs of development, management, and control. Actually the federal (or state) government would get 75 percent at the time of cutting since the payments to local governments would begin upon the inception of the agreement and would consequently have been fully met by the time of the timber harvest. The proportions as given above should be thought of

as purely illustrative. A great variety of percentages of yield going to each party to the contract would need to be provided for to take care of diverse situations with respect to the condition of the land, the stand and maturity of the timber, and the location of the land with respect to markets that would be encountered.

Problems Relating to Division of Yield and Income

There are a number of special problems relating to the proportion of the yield that shall go to each one of the contracting parties:

(1) The problem of the return to be made to the private owner, for instance, is one that relates directly to the value and productiveness of the land, the amount and quality of the timber already upon it, and to the prospective costs of management and development. Owners would, of course, be entitled to less if their lands were entirely denuded, or even worse, covered with a species of weed tree, or, as in the Ozarks, a heavy overstory of defective crowns. In any plan of management and control, yields and costs must be forecast. Separate bargains would need to be driven between government and owner for practically every tract. The government would have an advantage over the private owner in that its dealings would be spread over a great acreage. It could depend, therefore, upon the relatively stable and predictable results that would accrue under average conditions. Unfavorable mistakes in calculating costs upon one tract would be compensated by favorable errors on others.

One element of flexibility with respect to these contracts is worth noting. Suppose that timber products should become scarce and that prices should rise unexpectedly after the contract had been made. The private owner under such circumstances would feel that he had received entirely too small a share of the harvest. In partial compensation for its unexpectedly favorable position in the matter, the government (now in control of management) would be justified in expending more than usual amount in the development of the property. A share in the benefits arising from these expenditures would accrue to the private owner and would mitigate his feeling of loss. In a contrary situation where the prospective outcome was unexpectedly poor, the government control of cost would again permit a degree, albeit at times a small one, of flexibility which might be used to protect its interests.

Parenthetically, it is perhaps worth noting also that state and federal governments and private individuals will share the losses from fire, insect destruction, and storm damage on the individual property. On the other hand, payments to local governments would not be subject to change because of these risks. This fact might at first be thought a disadvantage to the participating state or federal government which must meet the tax costs. Reflection will reveal, however, that the disadvantage is a minor one only because, over a large acreage, unfavorable circumstances in one area will be balanced by the favorable elsewhere.

(2) The difficulties in connection with the establishment of the equivalent of the percentage of the yield to be allocated to the local government ordinarily will not be great. Perhaps this percentage should be the approximate equivalent of the 25 percent of gross receipts that the Forest Service agrees to pay for schools and roads in its national forests at present. Perhaps it might equally well be arranged upon the basis of an average forecast tax rate, common to the local government in question, applied to an average assessed valuation of the timberland involved. The former method would probably be more equitable, though from a legal or constitutional viewpoint there may be advantages in the latter.

The percentage of yield or the amount of the payments in lieu of taxes to be made to local governments would need to be fixed in advance for a period of years. One of the great drawbacks of private persons with respect to the development of their timberland holdings has been the impossibility of forecasting and controlling tax costs. Under the general property tax system the owners of timberlands are at the mercy of local taxing officials. Their position is particularly vulnerable just before the harvest when the combined value of land and timber is at its peak. An increase in assessments or an increase in tax rates at this critical period may easily rob the owner of all of his profits, or, as commonly happens, may force him to cut immaturely. To get away from this contingency the payment in lieu of taxes must be determined in advance.

When it is so determined, tax costs are brought under control and risks from this source eliminated. However, the course of taxes has been upward, and to fix permanently the taxes for any particular class of property would be to grant it a privileged status. Courts would surely count any such privileged status as contrary to law. The contracts with the local governments should, therefore, be sufficiently flexible to take into account changes in the burden of taxes. This element of needed flexibility can be obtained by making provision for periodic revisions in the contracts. The periods between revisions should probably reflect the length of the timber rotation. The cutting of any significant portion of the timber might be made the signal for a revision of tax payments. The change made should reflect not only the general upward movement of taxes, but should take account of changing local needs as well. Some quasi-official board to determine what changes are needed will have to be set up as a part of the program.

(3) The percentage of the harvest going to the controlling government (federal or state) should depend almost wholly upon the costs of management and control. The only difficulty involved in this connection is that of forecasting costs. Indeed it has been the uncertainty with respect to future costs and prices that has kept the private owner from developing his lands for timber production. The effect of the propositions outlined here would be to place the problem of finance in government hands where, because of the long wait for and the uncertainty of the income, it appears to belong.

The government has a number of advantages in acting as the financial agent in cases of this kind. As contrasted to the private owner, it would be in an advantageous position in the matter of management and control costs for a number of reasons. First, these costs to government could be forecast with a minimum of error because of the great acreage it would control. Risks of fire, insect, and storm damage, for instance, would be readily calculable for large acreages, though essentially uncalculable for a smaller acreage. Second, the size of the undertaking would also insure relatively small overhead costs per acre or per M.b.f. for the government though they would be large for numerous private owners each with a small acreage. Third, while the individual gains little or nothing from flood control, and scarcely anything from the restoration of game habitat and from the regularization of stream flow, all of these are of trancendent importance from a governmental viewpoint. No private owner could afford to offset such benefits against cost. The government can.

Flexibility in the Easement and Control Contract

In order to obtain the necessary control the government will need an easement in the land and a control contract which may or may not be made a part of the easement. Certain of the problems arising in connection with these easement and control contracts can be foreseen and provided for in advance.

(a) Individuals must have the right to transfer or sell the property subject to the easement and control contract. The need for this right hardly needs substantiation. Death comes to all individuals and bankruptcy to some. The need for changes in ownership in these cases is mandatory and only if the right of transfer is retained by the individual, can the need be met.

(b) The rules governing the right of the individual and the government with respect to cutting are also important. There should be some flexibility in selecting the time for cutting in relation to market prices. Too great flexibility would go far in ruining the effectiveness of the entire program, however. The need for a resort to some form of the democratic process referred to by Mr. Silcox in his annual report will, in this case, be necessary. Perhaps for each area or district involved a board of arbitration should be set up to act on all matters with respect to cutting and management where the individual and government are in conflict. However, certain broad rules such as the cutting to diameter limits, the disposal of slash, etc., can easily be made in advance and written directly into the easement contract.

(c) Rights of ingress and egress should be specifically taken account of in the easement and control contracts. The individual owner may wish permission to use the tract for camping, hunting, fishing, and outdoor sports generally. There is a certain security in the use of one's own property even when subject to an easement that it may be desirable

to retain for the owner. For these reasons, while government should have the general right of ingress, egress, and control over the property at all times, certain specific and enumerated rights could be preserved for the individual. The government may, however, since it will no longer purchase the land outright, need to provide in the easement for specific permission to build and maintain the necessary roads, telephone lines, etc., through each and every property.

(d) Regulations regarding the granting of special use permits which will be necessary, will require some modification. There will normally be three parties to the special use permit transactions: namely, (1) the government, (2) the individual, and (3) the lessor or the individual requesting the permit for special use. Where the owner, as will occasionally happen, wishes a special use permit with respect to his own land, the number of parties involved will be reduced to two. The division of timber yields as provided for above would not be applicable to the division of receipts from the special use permits. There will arise, therefore, a need to study costs of and receipts from each permit granted. The government will need to protect its interests in the growing timber, and should set aside from the receipts of these special use permits a reserve to cover an equitable portion of its responsibility to maintain tax payments to local government and to cover the cost of granting the permit. All receipts, after these reserves have been provided, should go to private owners. Almost certainly it will be impossible to cover in advance all possible contingencies arising with respect to the special use permits. An additional function of the arbitration board, referred to in connection with possible controversies over cutting dates and harvesting methods, would be the settling of controversies over special use permits.

(e) Perhaps also these arbitration boards could be used to settle disputes in connection with allowances to individuals for stands of timber upon the land to which the easement was to be applied and for other allowances or reductions because of other peculiar conditions of the land at the time of writing the control contract.

A Forest Conservation District Law

To inaugurate its part of the program the federal government will have to provide enabling legislation to permit the Forest Service to enter into cooperative agreements with state governments and private individuals respecting the management and control of the forest lands under consideration. State governments will need to pass enabling acts providing for "forest conservation districts." The provisions for these districts should be quite similar to those for soil conservation districts. In fact, there might be material advantage in pressing for the passage of enabling acts for both kinds of districts at the same time.

These forest conservation district laws should be so written as to permit a number of individuals owning tracts of land in reasonable contiguity with one another, and totaling not less than perhaps 20,000 or 30,000 or more acres to petition the state government for permission to establish a forest conservation district. It would not be necessary to have every owner within the district enter his land[5] though the percentage of area participating should probably not fall below 75 or $66\frac{2}{3}$ percent. The enclosed owner not entering his land, however, should be notified of his responsibility for fires developing on his lands and likely to spread to lands and forests of adjacent owners. The knowledge that such responsibility would be his would surely put upon him a heavy pressure to enter his lands along with those of the others. Yet, the requirement that he be responsible for control of fires developing on his land is an eminently reasonable one not likely to offend resident people as an arbitrary exercise of power.

In addition to the enactment of forest conservation district legislation, however, there will be needed provisions which will permit the federal (or state) government to make the necessary payments to local governments in lieu of taxes as provided above. So many of the local governments are in serious financial difficulties that some such provision must apparently soon be made, in any event, if or-

[5]In this respect the formation of forest conservation districts will be advantaged as compared to the formation of soil conservation districts, which can be blocked by a few recalcitrant owners or operators.

ganized government is to continue in the many deforested areas.[6]

Will Counties Cooperate?

Since local governments have an interest in the matter, their wishes must also be consulted before the final contracts for the control, management, and distribution of products are drawn up. Consent of the county to the establishment of the district may occasionally be difficult to secure, though there are so many advantages to the locality in connection with the program that it is difficult to see why they should withhold their consent.

Opportunity to present objections to their establishment must, however, be provided, and a public meeting at which they may be heard should be held in much the same manner as now provided prior to the enactment of zoning ordinances.[7] The only referendum required will be the polling of the owners of the land within the district. The right to vote should probably be granted to the operators or residents as well as to the owners. However, tenancy in forest land areas is unimportant, so that no difficulty on this account should arise.

Permission to Withdraw

Provision should be made, also, for permitting the land owners to withdraw from the district for reasons considered sound by some such board of arbitration as provided for above in connection with cutting. The withdrawal should be contingent upon the re-payment to the government of such costs as have been incurred in connection with the particular tract or tracts of land, and some just apportionment of overhead costs to be approved, perhaps, also by the board of arbitration. To protect the interest of the government in merchantable timber on the land withdrawn, provision should be made to permit government to cut or sell the stumpage prior to the withdrawal.

Will Land Owners Cooperate?

With respect to the feasibility of the program the question immediately arises: Will private owners of land be willing to enter their lands in the forest conservation district? Of course, no answer can be given to this question until the program is given a trial. However, it is to be remembered that these private owners have for the most part been disillusioned with respect to the prospect of selling these lands or developing them for farming. As noted above, a great acreage of these lands is tax delinquent and the owners are obviously distressed to know what to do with them.

That great numbers of private owners would welcome enthusiastically the proposal that they continue their moderate investment in forest land while turning it over to the government for administration and development is not an indefensible forecast. At any rate it seems safe to predict that the owners of forest lands would welcome the forest conservation district law herein proposed more enthusiastically than farmers have welcomed the soil conservation district proposals.

One further aspect to the program likely to exert a powerful influence upon the owner to enter his land is the protection from theft that can be provided as a by-product of other protection and administration activities. In almost all timber-growing areas left is a constant risk, and in some areas a major deterrent to any attempt at private forest development, particularly of small and isolated tracts of land.

There is, fortunately, sufficient flexibility in the easement and control contracts that will be drawn so that the attractiveness of the conservation program to the individual owner can be adjusted. Few owners, indeed, would refuse to enter their lands if they were to be given as much as 75 percent of the timber yield at the end of the rotation with government paying all costs. Perhaps a very large number could be attracted if the average yield were reduced to 50 percent. The number that would be attracted at 25 percent would be smaller. By its ability to adjust these percentages the government would, indeed, have a means of controlling precisely the rate at which it accepted land for administration and development.

Conflicts will occur over the amounts that should be allowed for taxes and costs of protection and administration, on the one hand, and the percentage of yield that should go to the individual for his investment, on the other.

[6] See for instance, the section dealing with "The problem of local government maintenance during the transition period" in Forest Restoration in Missouri. Mo. Agric. Exp. Sta. Bull. No. 392.

[7] See the discussion of steps to take to enact a rural zoning ordinance in Chapt. VI in Land use in Northern Minnesota by Jesness and Nowell. University of Minnesota Press, 1935.

An insistence on the part of the government that its margin to cover costs be liberal would tend to discourage the owner from entering his land. A more lenient attitude on the part of the government would have a counter effect.

Public Attitude

There would, indeed, be many accusations, no matter how hard a bargain is driven, that private owners were treated too leniently by a government which undertook all costs for taxes and administration, and yet gave the owners a share of the product. Many people believe that the bulk of these lands are essentially worthless, and the fact that so many of them are tax delinquent lends validity to this belief. Under a carefully administered program, however, those who believe that the government has the best of the bargain should about equal in number those who believe that the private individual has gained most. Government sponsorship for the program should, therefore, be under no particular deterrent from this score. If, as the author believes, the time is ripe to act on the conviction that the productiveness of these timberlands should be restored, the program herein suggested is timely, and while it will need shrewd administration it will probably lead to less criticism than would the attempt to place the 359,000,000 acres under public ownership as proposed in the National Resources Board report.

The Savings to Government

The question as to whether or not there would be a material saving to government in the purchase of the necessary rights as contrasted to ownership rights brings up a crucial point. The National Resources Board report of December 1, 1934, states that "acquisition costs of the program of public forests recommended by the Forest Service, judging by the experience under the Weeks and Clarke-McNary Acts, would average four dollars per acre and commercial stumpage twelve dollars per thousand." They state also that "To meet desirable popular objectives in protection and administration of the national forests would require annual expenditures averaging 12.2 cents per acre."[8] This 12.2 cents per acre is compared with the 8.1 cents per acre provided in the past. The government would, of course, be faced with about the same costs for capital investment in fire towers, roads, etc., as at present. These are estimated in the same report as two dollars per acre in the East and a dollar per acre in the West.

The average costs for taxes upon these forest lands are usually low. Tax rates in thirty-five Missouri counties embracing the greater bulk of the forest lands in the state, averaged for 1935, $1.36 per $100 of assessed valuation. Assuming that the forest lands over which the control was obtained would be appraised at approximately $4 per acre (assessed valuation is normally lower than full value), the average tax would be 5.5 cents (that is, $1.36 \times 4.00 = 5.5$). Adding this average tax of 5.5 cents to the 12.2 cents cost estimated for protection and administration gives a total of 17.7 cents per acre. If these figures are representative, the government could protect, administer, and pay taxes on these lands for a period of 22 years before the cost (17.7 cents would equal the appraised value ($4), leaving interest out of account. But interest must be taken into account, and at 3.5 percent the interest on $4 is 14 cents the first year or a sum not much less than the 17.7 cents for costs. The problem then becomes: how long does it take for an annuity of 17.7 cents cumulated at 3.5 percent to equal an investment of $4 cumulated at the same rate? The period is, of course, greatly lengthened and amounts, for this particular illustration, to 45.5 years. That is, over a 45.5 year period, long enough for a complete timber rotation in most areas, the costs for protection, administration, and taxes would be just equal to the cost of buying and carrying the land. The period required for costs to equal land investment and carrying charges would be somewhat shorter if land costs were lower, say $3 per acre. In any case the difference in costs under the two methods is imposing.[9]

The comparison of costs upon the basis used above does not, however, take into account initial investment costs of $2 an acre that would be needed before any system of control or management could become effective. The costs of the two systems of outright control and purchase of control rights only, taking these in-

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[8]For both first and second quotations see P. 215, National Resources Board Report, December 1, 1934.

[9]The author is indebted to Prof. B. H. Frame, statistician of the Missouri College of Agriculture, for aid in determining the differences in cost under the two programs.

vestment costs into account, are compared for both $4 and $10 land in Table 1. In calculating the government's investment under the two systems, it has been assumed that the $2 investment cost was made immediately, and that the costs for administration, protection, and taxes are the same under each system. No account is taken of possible incomes to offset costs over the period.

Assuming a rotation period of 50 years, the government would have invested in the case of $4 land $56.70 per acre under the purchase method, and only $34.36 per acre under the purchase of control method. That is, over the 50-year period the investment under the purchase plan would be $22.34 per acre, or 35 percent greater than under the purchase of control method. In other words, under the purchase of control method, the private investor would carry a $22.34 (35 percent) share of the investment burden.

However, taking costs over the rotation period presents the possible savings in too favorable a light except in cases where the rotation period and income cycle coincide in length. The income cycle is of course much the shorter of the two normally and, in a sustained-yield forest income accrues continuously. Nevertheless in the United States there will, of necessity, be a long period of waiting before our forests can be put upon a sustained-yield basis. If this period is from 20 to 30 years averaging say 25 years the more accurate appraisal of savings occurs in connection with this shorter period.

Accepting for illustrative purposes the 25-year average period the savings to the government by changing to a purchase-of-control-only program would be significant even in so limited an area as Missouri. To begin management upon the 12,000,000 acres remaining to be brought under control in this state, the government would require $74,124,000 under the purchase plan, and under the alternate plan only $26,124,000. After a 25-year wait the costs would be $252,840,000 with and $139,440,000 without purchase. The difference in costs would be much greater for the 359,000,000 acres projected for purchase in the United States as a whole and would amount at the end of 25 years to more than $3,000,000,000.

Even the figures above do not fully state the difference in cost to the government in the two alternative programs. One of the more expensive items in the outright purchase program is the buying of merchantable timber. Restricting the purchase to the rights of administration and control does away entirely with the need to buy merchantable timber.

A second advantage occurs in connection with the extension of the program of management to the more valuable lands, that is, to those approaching marginal crop land in quality. The federal Forest Service has not purchased any great acreage of such lands. Under the Submarginal Land Purchase Program the problem of reforesting a class of lands somewhat more valuable than those that the Forest Service has so far been purchasing, has been recognized. In the Clark National Forest Unit in Missouri, the Resettlement Administration has bought a large acreage of such land, and turned it over to the Forest Service. The purchase price per acre was about $6, or perhaps three times as much as will be the average cost of forest land at the completion of the national forest purchase program in this unit.

Extending the conservation program under the purchase of control rights to this higher priced land involves only a modest increase in costs above those for lower valued land, as a comparison of costs for $4 and $10 land as in Table 1 will reveal. Costs for administration and development should be no greater, and the only increase will occur in the costs for taxes. Indeed, the higher the value of the land involved, the greater is the advantage of the purchase of control rights only over the outright acquisition of title by the government.[10]

A third advantage appears when the plan is viewed from the standpoint of government and the section of government that would administer the program, that is, the Forest Service. Without the necessity to purchase the land and timber, the Forest Service could use the monies now assigned to it for acquisition to obtain the

[10]In a letter to the author Ward Shepard, Director of the Harvard Forest, calls attention to an additional advantage. He states: "There is an even further advantage which should be stressed. The acquisition program is compelled, on account of the costs involved, to limit itself largely to lands containing very young growing stock, so that the period of waiting for return on the investment is exceedingly long. Your plan should reverse the psychology and put the emphasis on acquiring control of lands from which an immediate flow of revenue could be expected."

needed equipment for management and control and for salaries and wages.

State Cooperation

The fact that state and federal governments would or could cooperate has been implied in a number of instances above. This cooperation might take on a number of forms depending upon the fiscal capacity of the state, and the stage of public opinion on conservation matters within the state. Under any circumstances the state will need to pass enabling legislation for the creation of the forest conservation districts. In most states also there is a constitutional requirement for uniformity in taxation. Constitutional amendments to permit the federal (or state) government to pay a fixed annual sum to local governments in lieu of taxes may need to be provided since the exact stand of the courts on this matter may be uncertain. If the courts will interpret the sums being granted to local governments as a satisfactory substitute for the property tax, and as being merely an administrative modification of the method of applying the tax, there need be no question of constitutionality arising. If, on the other hand, the view is taken that the payments arising under this program constitute a tax concession to forest lands and that they are not the equivalent of taxes collected by other methods, the provision would be regarded as unconstitutional.

There are a number of additional things the state might do in order actively to participate. For instance, where reversion laws providing that the title to tax delinquent lands shall pass to the state or county governments are not in the statutes, such laws should be enacted. Such state or county owned land acquired by reason of these reversion laws could then be entered directly into the program along with privately owned land. The state could certainly be asked in all cases to rebate state property taxes on the entered land, and there is good reason to believe that many states would be justified in making direct appropriations, even in bonding themselves in order to promote the creation and development of the forest conservation districts, either with or without the aid of the federal government.

Table 1.—The Government's Investment in Land and Timber under Methods of Outright Acquisition and Purchase of Control Only

	$4 Land		$10 Land	
Year[1]	Acquisition of ownership	Purchase of control	Acquisition of ownership	Purchase of control
1	$ 6.177	$ 2.177	$12.258	$ 2.258
5	8.08	3.33	15.63	3.76
10	10.54	4.90	19.95	5.84
15	13.47	6.77	25.08	8.33
20	16.95	8.99	31.18	11.28
25	21.07	11.62	38.41	14.78
30	25.98	14.75	47.00	18.93
35	31.80	18.47	57.20	23.87
40	38.72	22.88	69.32	29.73
45	46.93	28.13	83.71	36.69
50	56.70	34.36	100.81	44.97

[1]End of year.

A Forest Credit Corporation

The possibility of employing a credit institution similar to the Farm Credit Administration, Federal Housing Administration, Reconstruction Finance Corporation, and Rural Electrification Administration, etc., to provide a certain portion of the funds needed to inaugurate and carry on the program is an intriguing subject. The federal government would not, of course, gain title to the land, but it would gain partial title to the timber being produced under a virtually permanent easement. This growing timber could be made a base upon which to issue debenture bonds. These bonds could be floated at very low interest rates if they are given government guarantees with respect to payment of interest as is provided at present for Farm Credit Administration bonds. That there would be genuine assets underlying these bonds is clear.

The value of income to be derived from the land of a particular forest conservation district and going to the government as its share could be predicted with reasonable accuracy in advance. If debenture bonds were issued to approximately 50 percent of such income, they should be a conservative investment. The issue of such bonds would, of course, accomplish no spectacular fiscal purpose since the federal government might issue bonds without resort to the hypothecation of this particular form of underlying security. Nevertheless, the use of the security would be of some significance since it would call the attention of the bond holders to the existence of the underlying property.

Summary of Advantages

The advantages of the proposed program may be summarized as follows:

(1) It requires the purchase of only the

necessary rights for purposes of control and administration of land use as contrasted to the much more expensive program of purchasing the full rights of ownership.

(2) It reduces the cost to government of forest conservation, and permits, therefore, the extension of a forest conservation program to a much greater acreage of land than can now be reached with a given appropriation.

(3) It provides some very badly needed aid to decrepit local governments in forest land areas. In Missouri, at least, many counties in such areas are virtually bankrupt.

(4) Since government would agree to pay subsequent taxes, it opens the way to a powerful attack on land tax delinquency which has been so marked a characteristic of these forest lands.

(5) It makes possible a widespread beginning upon a badly needed program of restoration of the productiveness of land resources in the Ozark, Lake States, and Appalachian Highland regions which are peculiarly in need of such restoration.

(6) If a Forest Credit Corporation is established it will give the government an added property base upon which to float bond issues to inaugurate the program. Obtaining the money by bonds will lessen the need for outright current appropriation of the needed money.

(7) Perhaps the greatest advantage of the plan occurs in connection with lands of relatively high value or those most unlikely to be reached by any program of ownership acquisition. The forest conservation program, under the proposed plan, may be extended to these higher value lands at little increase in cost.

An Alternative Plan

An alternative plan of great interest that avoids the problem of constitutionality with respect to payments to local governments in lieu of taxes and also does away with the necessity of the formation of formal forest conservation districts has been suggested by M. C. Williams and R. J. Silkett of the Farm Security Administration.

This alternative plan involves a setup very similar to that of the modern corporation. The private owner would contribute his lands and timber in exchange for the right to participate in income. The government would undertake management, control, and development in exactly the same fashion as outlined in the preceding plan. The ceding of property to the government by the private individual would, however, go much further in this alternative plan. That is, the owner would deed outright ownership to the government in return for certificates granting him the right to participate in income.

Since local governments cannot tax the property of the state and since neither local nor state governments may tax the property of the federal government, this alternative method would avoid the question of the constitutionality of the payments to be made to local governments. Both plans, however, provide for payments to be made to local governments, and the determination of the amount of the payments would be essentially alike under both plans. However, under the alternative plan the federal government would be in complete control of the payments to be made and would need to consult neither state nor local governments in the matter. The ability to make a widespread use of the power might make it appear an autocratic use of authority.

Under this corporative type of plan the land and timber of each owner would be appraised separately. An administrative district would be set up, and the total appraised value of the land of all owners in the districts contributing their land would constitute the paid up capital of the enterprise or project. The timber could be entered merely as additional capital, or, in the case of merchantable timber, a certificate providing for earlier or preferred participation in income could be given.

The identity of the property of the individual owner would be lost or be merged with that of all others. This procedure would simplify administration of the forest district materially. Harvesting and developmental plans could be inaugurated for the entire district without regard to property lines or to the wishes of the individual property owners.

Because a control of costs can be made also to mean a control of income, and because of the helplessness of the individual in any contest with the government, some provision for guaranteeing a reasonable return to the owner entering his lands needs to be made. Perhaps this provision could be much the same as that suggested in the original plan. That is, the government could agree to return to the pre-

vious owners some fixed percentage of the total yield at the time of cutting. Thereafter, the government and the previous owner could share pro rata in any excess of income above costs.

In addition to avoiding the issue of constitutionality with respect to tax payments, this alternative plan has many advantages over the original. It simplifies administrative procedure and probably would lead to a reduction in the number of disputes between the owners and government. It would reduce very materially the amount of accounting and bookkeeping work that would be necessary. Because the entire forest conservation district would eventually be placed upon a sustained-yield basis, it would be possible to make annual returns to each owner upon a dividend basis. Under the original plan with the identity of the original owner tracts retained, the receipts of income by the owner will always be irregular. Finally, this last plan would have an advantage from a credit viewpoint, since, under this latter plan the government has actual title to the land itself and has, therefore, a more acceptable security to offer for the bonds it may wish to issue.

RELATION OF INCIDENCE OF NEEDLE DISEASE IN LOBLOLLY PINE PLANTATIONS TO CERTAIN PHYSICAL PROPERTIES OF THE SOIL

By E. RICHARD TOOLE[1]

Duke School of Forestry

The southern pines, especially longleaf pine, are very susceptible to at least two important needle diseases. Of these the brown-spot disease is by far the more important. It was found that the amount of infection of the brown-spot fungus varies with the age of the plantation, but no relationship was found between incidence of infection and the physical properties of the soil. This paper is of particular interest to forest pathologists because of the new application that is made of statistical methods to the study of tree diseases.

ASIDE from fire, needle diseases are among the most destructive maladies of young plantations in the southern pine region. In order to combat these diseases it is particularly necessary to have information on the factors which affect their growth and development. The occurrence and prevalence of the various plantation diseases is influenced to a large degree by the quality of the site, and, since forest plantations are often made on areas having more or less adverse site conditions, they are especially subject to attack by pathogenic fungi. For the successful growing of forest plantations the selection of suitable sites is of utmost importance (*1*, *2*).

Certain physical properties of the soil are thought to be of use in measuring site quality (*5*). It might be anticipated that they would be correlated with the incidence of needle diseases. In order to test this possibility a study was conducted to determine whether there is any relation between physical properties of the soil and incidence of infection with needle diseases in pines.

A preliminary survey of the pine plantations of the Duke Forest has shown that needle diseases are very common. On several of the badly eroded sites these diseases appear to be very severe on loblolly pine (*Pinus taeda* L.), infecting nearly all of the needles on many of the trees. The killing and browning of the young needles is largely caused by two pathogens; (1) the brown-spot organism, *Septoria acicola* (Thüm.) Sacc., and (2) the needle-cast disease caused by *Lophodermium pinastri* Schrad.) Chev. Of these, *S. acicola* is the most noticeable. The fruiting bodies of both *S. acicola* and *L. pinastri* were commonly found on the same needles, making it rather difficult to separate these two diseases. Because of the apparently close relationship between these two fungi, no attempt has been made to separate them in this study, although the infec-

[1]The writer is indebted to Dr. F. A. Wolf for his advice and criticism during the progress of this work, and to F. X. Schumacher and T. S. Coile for many helpful suggestions.

tion data may be considered to apply more particularly to the brown-spot organism.

The brown-spot disease occurs on most of the southern pines, but is most injurious on seedlings of longleaf pine (*Pinus palustris* Mill.) because of the low rosette type of growth which is characteristic of this pine in the early stages of its development. Hedgecock (*8*), Siggers (*11*), and Verrall (*14*) have reported studies of this disease on longleaf pine.

The needle-cast fungus is commonly found fruiting on fallen needles of most of the pines. It has only recently been recognized as of pathologic importance in this country, although it has long been serious in Europe. Spaulding (*13*) reports this disease to be destructive to young red pine (*Pinus resinosa* Ait.) in nursery seed and transplant beds in Massachusetts. This is the only report of serious damage caused by the needle-cast organism in the United States.

Previous Work

So far as the writer knows there has been no previous attempt to examine the relation of incidence of forest diseases to physical properties of the soil, although certain work has been done in a closely related field, the relation of site quality to physical properties of the soil.

Coile (*5*) in studying the relation of site index for shortleaf pine (*Pinus echinata* Mill.) to physical properties of the soil found that there was no well defined correlation between site index and any one physical characteristic of any one soil horizon. However, he found that a texture-depth index, obtained by dividing the silt and clay content in percentage of the B_1 horizon by the average depth in inches of the A horizon, was rather closely related to site quality.

Hicock *et al* (*9*) found that as a rule the character of the soil had only a slight correlation with the site index in their studies of the relation of certain soil characters to growth of young red pine plantations in Connecticut. They observed fairly good correlations only between low site values and low values of soil characteristics studied.

Haig (*7*) in measuring the value of colloidal content of the A, B, and C horizons as indicators of site quality found a definite correlation between site index and colloidal content of the A layer.

Methods of Study

The present study has been limited to loblolly pine plantations, since loblolly pine is one of the principle species used in administrative plantings in the Duke Forest (*10*).

There are 127 loblolly pine plantations in the Durham Division of the Duke Forest within the age groups 1931 to 1937. For this investigation thirty of these plantations were selected at random. The location and distribution of each by soil series and age of plantation is shown in Table 1. Within each of these plantations 2 one-tenth acre plots were located at random, and a random selection of 10 trees within each plot was made.

The incidence of disease was obtained by calculating the percentage of infection for each of the 600 trees measured. These figures were arrived at by measuring the length to the nearest tenth inch, of the needles killed or browned, and dividing by the total length of the needles. The following sampling method was used: Random collections of needles were made, considering only the youngest needles. Because these diseases are most serious near the ground, no samples were taken above a height of five feet. From each tree 25 fasicles were collected; 5 chosen at random from each of 5 levels. Of these, 2 fasicles were taken from each group of 5 and the percentage of infection determined. The plot averages are shown in Table 1, column y.

The depth of the A horizon was measured in inches for each tree, using a soil auger.

The height of each tree was measured in inches.

Five shallow pits were dug at random locations within each plot and composite plot samples of the A and B horizons were collected separately. A complete mechanical analysis of these 120 samples was made in the laboratory. The hydrometer method of soil analysis proposed by Bouyoucos (*3*, *4*) was used. Table 1 gives the plot averages for the six properties of the soil analyzed, namely "total colloidal content," silt and clay content, and fine clay content of the A and B horizons separately.

Analysis and Discussion of Results

The design of this experiment is such that the average value of the dependent variate y, or incidence of infection, can be expressed in terms of the eight independent variates, x_1, x_2,

x_3, x_4, x_5, x_6, x_7, x_8, or depth of A horizon, height of tree, "total colloidal content," silt and clay content, and fine clay content of both the A and B horizons (see Table 1). In speaking of depth of A horizon, height of tree, "total colloidal content," silt and clay content, and fine clay content of the A and B horizons as independent variates, all that is implied is that it is in terms of them that the incidence of infection is to be expressed; it is not implied that these variates vary independently, in the sense that they are uncorrelated.

To test the differences in infection among the age classes and soil series the infection data was subjected to an analysis of variance using methods given by Fisher (*6*). The results are shown in Table 2.

The comparison of the mean square "between age classes" with that for "plots within age classes and soil series" gives an F value of 6.484 (see Table 2). Reference to F tables shows that this value exceeds the value of F which would be attributed to random sampling alone. This demonstrates that the probability that the differences in the mean squares due to chance alone is less than one in one hundred. This means that there are definite differences between the age classes above and beyond differences due to experimental error. Therefore it can be concluded from Table 1 that infection is most severe in the youngest plantations. This agrees with the findings of Siggers (*11*) and others with respect to the brown-spot organism on longleaf pine.

The comparison of the mean square "between soil series" with that for the "age class within soil series" source of variation shows no significant departure from differences which could be ascribed purely to chance.

To ascertain the effect of each variate separately, regression values were determined in turn for each independent variable and incidence of infection. For example, testing the relation of depth of A horizon to incidence of infection in the case of the "plots within age class" source of variation the value for the regression mean square is found to equal 1.424113; the mean square independent of regression is 18.960948. The ratio of the larger to the smaller of these mean squares gives an F value of 13.31 which by referring to Snedecor's (*12*) tables of F is found to have no significance. In a similar manner each of the other variants were found to have no significant effects.

To determine whether there was any relationship between the incidence of infection and the eight independent variables measured, multiple regression equations were worked out and the partial regression coefficients were found, using the methods of least squares as given by Fisher (*6*) and Snedecor (*12*). The analysis of variance for the regressions based on the "between age classes" and the "plots within age class and soil series" sources of variation is shown in Table 3.

Comparing the mean square due to regression with that independent of regression for the "plots within age class and soil series" source of variation gives an F value of 2.336 (see Table 3) which cannot be shown to have any significant effects. In testing the significance of the regression for the "between age classes" source of variation the F value, 1.254, is found to be smaller than that which would be expected were all effects due entirely to chance. No significant relationship can be shown from these data between the eight variables studied and incidence of infection. Therefore, variations in the physical properties of the soil studied apparently had no influence on the prevalence of needle diseases during the 1937 growing season.

Before it can be said that the incidence of the needle diseases of southern pine is unaffected by site, further investigation of the interrelation of other soil factors, as well as of weather conditions must be made.

Summary

The relation of certain soil characters and height growth to incidence of needle diseases in young loblolly pine plantations was studied.

It was found that there was a significant difference in amount of infection varying with age of the plantations. Infection seems to be most severe in the youngest plantations, 2 or 3 years old.

No relationship was found between incidence of infection, height growth, or the seven physical properties of the soil studied.

It is probable that interaction of other factors of the site on these leaf diseases should be given further consideration.

Literature Cited

1. Baxter, D. V. 1933. Observations on for-

TABLE 1.—AVERAGE PLOT VALUES FOR INCIDENCE OF NEEDLE DISEASE IN LOBLOLLY PINE PLANTATIONS IN THE DUKE FOREST IN RELATION TO HEIGHT OF TREE AND PHYSICAL PROPERTIES OF THE SOIL ARRANGED ACCORDING TO SOIL SERIES AND AGE CLASS[1]

Soil series	Year planted	Location: Compartment No.	Location: Plantation No.	Location: Plot No.	y	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
Gg	1933	76	1	1	2.4	0	65	72	81	62	0	0	0
Gg	1933	76	1	2	3.1	5	109	71	81	56	62	71	42
			Subtotal		5.5	5	174	143	162	118	62	71	42
Ir	1932	53	1	1	15.4	5	47	65	81	51	47	66	31
Ir	1932	53	1	2	10.3	6	77	66	80	55	45	64	31
			Subtotal		25.7	11	124	131	161	106	92	130	62
Al	1937	66	2	1	0.6	4	12	57	81	36	38	63	19
Al	1937	66	2	2	2.5	6	13	44	68	24	28	54	13
			Subtotal		3.1	10	25	101	149	60	66	117	32
Al	1936	66	1	1	4.3	7	44	52	69	31	36	59	18
Al	1936	66	1	2	2.5	6	35	28	39	15	33	50	17
			Subtotal		6.8	13	79	80	108	46	69	109	35
			Subtotal		9.9	23	104	181	257	106	135	226	67
D	1935	M	3	1	5.3	12	40	22	28	14	13	19	7
D	1935	M	3	2	4.8	13	49	30	37	17	13	20	8
			Subtotal		10.1	25	89	52	65	31	26	39	15
D	1932	72	1	1	12.5	10	161	37	44	25	13	20	7
D	1932	72	1	2	6.8	10	158	41	47	29	16	24	10
D	1932	72	3	1	5.5	25	130	23	35	12	8	16	3
D	1932	72	3	2	2.3	14	152	23	32	12	9	18	5
			Subtotal		27.1	59	601	124	158	78	46	78	25
			Subtotal		37.2	84	690	176	223	109	72	117	40
Ap	1937	70	4	1	0.6	10	9	31	38	21	11	18	7
Ap	1937	70	4	2	11.0	13	9	29	36	19	9	16	5
			Subtotal		11.6	23	18	60	74	40	20	34	12
Ap	1935	68	2	1	11.7	6	30	47	57	26	22	32	14
Ap	1935	68	2	2	4.9	11	47	57	67	44	16	27	10
			Subtotal		16.6	17	77	104	124	70	38	59	24
Ap	1933	78	4	1	12.9	13	134	39	50	27	16	26	10
Ap	1933	78	4	2	2.1	12	126	55	61	39	24	32	14
Ap	1933	77	1	1	3.3	11	125	40	50	27	9	17	5
Ap	1933	77	1	2	4.3	10	139	39	48	28	11	19	7
			Subtotal		22.6	46	524	173	209	121	60	94	36
Ap	1932	71	1	1	10.2	0	66	52	66	30	0	0	0
Ap	1932	71	1	2	5.3	7	140	35	43	24	12	22	8
Ap	1932	72	4	1	5.1	9	154	33	42	22	14	23	9
Ap	1932	72	4	2	6.9	10	143	40	45	26	14	23	8
			Subtotal		27.5	26	503	160	196	102	40	68	25
			Subtotal		78.3	112	1122	497	603	333	158	255	97
W	1937	41	1	1	3.5	4	8	53	73	43	14	25	9
W	1937	38	5	1	7.4	7	7	51	59	44	12	19	8
			Subtotal		10.9	11	15	104	132	87	26	44	17
W	1936	T	4	1	9.0	2	13	49	64	37	39	54	30
W	1936	T	4	2	13.3	8	22	37	49	28	13	22	8
W	1936	T	3	1	10.9	2	14	32	45	25	22	33	16
W	1936	T	3	2	23.2	6	16	51	67	39	31	46	22
W	1936	T	1	1	3.5	3	22	27	42	20	24	39	17
W	1936	T	1	2	3.3	5	20	52	68	41	19	35	12
W	1936	42	1	1	4.4	5	15	65	79	55	23	40	17
			Subtotal		67.6	31	122	313	414	245	171	269	122
W	1933	52	6	1	39.7	3	32	39	51	32	28	39	21
W	1933	52	9	1	33.1	7	52	57	77	44	17	29	12
			Subtotal		72.8	10	84	96	128	76	45	68	33
			Subtotal		151.3	52	221	513	674	408	242	381	172
Gv	1937	37	4	1	7.8	8	6	35	41	28	16	25	10
Gv	1937	37	4	2	13.1	11	8	24	32	17	9	16	6
Gv	1937	38	5	2	13.5	15	10	40	49	30	8	15	4

TABLE 1.—(*Continued*)

Soil series	Years planted	Location Compartment No.	Plantation No.	Plot No.	y	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
Gv	1937	38	4	1	9.0	10	8	45	59	38	11	21	8
Gv	1937	38	4	2	7.7	9	8	43	60	33	11	24	8
Gv	1937	41	1	2	10.6	21	9	26	36	19	7	16	5
Gv	1937	40	4	1	17.7	5	6	51	59	43	15	24	11
Gv	1937	40	4	2	6.8	13	6	39	44	34	8	17	5
Gv	1937	40	6	1	14.0	18	9	26	34	18	9	17	6
Gv	1937	40	6	2	6.4	13	9	26	37	19	9	15	5
Gv	1937	41	5	1	11.9	8	5	32	41	25	10	22	7
Gv	1937	41	5	2	10.4	16	5	27	41	19	12	24	7
			Subtotal		128.4	147	89	414	533	323	125	236	82
Gv	1936	42	1	2	11.8	10	18	36	57	25	17	39	9
Gv	1936	38	2	1	9.8	5	20	59	70	48	14	24	10
Gv	1936	38	2	2	5.8	8	19	37	51	27	10	22	6
			Subtotal		27.4	23	57	132	178	100	41	85	25
Gv	1935	16	1	1	9.4	4	25	49	58	40	22	30	16
Gv	1935	16	1	2	5.0	10	30	30	38	22	10	17	7
Gv	1935	17	1	1	3.5	6	27	36	45	30	18	28	12
Gv	1935	17	1	2	12.1	10	34	44	50	37	13	21	9
			Subtotal		30.0	30	116	159	191	129	63	96	44
Gv	1933	52	6	2	12.0	9	102	28	42	20	12	25	6
Gv	1933	52	9	2	13.4	11	106	36	53	27	20	27	6
			Subtotal		25.4	20	208	64	95	47	32	52	12
Gv	1932	31	1	1	3.0	11	132	41	51	34	15	16	12
Gv	1932	31	1	2	7.8	11	146	29	40	24	14	24	9
			Subtotal		10.8	22	278	70	91	58	29	40	21
			Subtotal		222.5	242	748	839	1088	657	290	509	184
			Total		530.4	529	3183	2480	3168	1837	1051	1689	664

[1]Legend for Table 1:
Gg=Georgeville soil series.
Ir=Iredell soil series.
Al=Alamance soil series.
D=Durham soil series.
Ap=Appling soil series.
W=Whitestore soil series.
Gv=Granville soil series.
y=Average percent of needle infection per tree; plot averages.
x_1=Depth of A horizon in inches; plot averages.
x_2=Height of trees in inches; plot averages.
x_3=Percentage "total colloidal content" of B horizon.
x_4=Percentage silt and clay content of B horizon.
x_5=Percentage fine clay content of B horizon.
x_6=Percentage "total colloidal content" of A horizon.
x_7=Percentage silt and clay content of A horizon.
x_8=Percentage fine clay content of A horizon.

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Table 2.—Analysis of Variance of Incidence of Infection

Source of variation	Degrees of freedom	Sum of squares	Mean square	F[1]	P[2]
Between soil series	6	656.192379	109.365397	1.154	>.05
Age class within soil series	11	1387.688644	126.153513		
Between age classes	17	2043.881023	120.228295	6.484	<.01
Plots within age class and soil series	42	778.822977	18.543404		
Total	59	2822.704000			

[1]F=Comparison of the ratio of the larger mean square to the smaller.
[2]P=Probability that this ratio is greater than or less than one or five out of a hundred chances obtained by comparing the F value obtained with corresponding values in Snedecor's (*12*) table of F.

Table 3.—Analysis of Variance of Regressions

Source of variation	Degrees of freedom	Sum of squares	Mean square	F	P
	Plots within age class and soil series				
Regression	8	71.258682	8.907335	2.336	>.05
Independent of regression	34	707.564295	20.810715		
Total	42	778.822977			
	Between Age Classes				
Regression	8	847.773683	105.971703	1.254	>.05
Independent of regression	9	1196.107340	132.900815		
Total	17	2043.881023			

RESULTS OF THE SOIL CONSERVATION SERVICE PROGRAM OF PLANTING TREES AND SHRUBS

By JOHN F. PRESTON
Soil Conservation Service

To date, the Soil Conservation Service has planted about 350 million trees on 217,500 acres of land. Much of this area represents poor planting sites and admittedly some mistakes were made in the selection of tree species. Nevertheless, on about 80 thousand acres of the 110 thousand acres examined the survival has been satisfactory.

SOMETIME ago, Mr. Fechner's office[1] was responsible for the issuance of news items which appeared generally in the press giving the statistical data showing the number of acres and millions of trees which the C.C.C. enrollees had planted. To most people the figures were quite impressive. However, one representative of the general public took it upon himself to write to Mr. Fechner's office asking the rather pertinent question as to how many of these millions of trees planted by the C.C.C. were living today. Mr. Fechner's office passed the inquiry to the several-using agencies, including the Soil Conservation Service, for a report of the actual survival. The Soil Conservation Service at that time was not able to give a complete picture of the exact status of the survival of plantations. Survival counts had not yet been made a matter of national record. Each individual project and camp forester, of course, had looked over his plantations and made his own analysis of the survival, and on the basis of this analysis, decided whether or not to replant. A complete, or nearly complete, report of the actual survival of all plantations made by the Soil Conservation Service is now available, and a summary of this report is published herewith.

Seldom does the result of tree planting, measured in terms of survival percentage, measure up to expectations. Unexpected difficulties always are encountered which interfere with the accomplishment of a perfect job. Tree planting by the Soil Conservation Service is necessarily on poor, eroded soils, because the purpose is to stop soil erosion. Therefore, with few exceptions, the sites alloted for tree and shrub planting are those from which the topsoil is gone. Furthermore, the planting always has been, at least up to the present time, more or less of a rush job. This was particularly true in the first years. Great masses of man-power, for which large quantities of planting materials were assembled, together with inexperienced foresters to supervise the job, naturally do not make a perfect combination. In tree planting it is recognized that C.C.C. labor may not be as efficient as other forms of labor; moreover the C.C.C. organization is not always as flexible as the planting job requires. In the rush days of 1933, 1934, and 1935 the Soil Conservation Service assembled foresters (and, in fact, its entire personnel force) from the far corners of the country; and in a great many cases, the foresters were inexperienced in large scale tree-planting operations. Therefore, a great many failures or poor survivals were due to poor inspection of stock; some stock which should never have been planted was accepted; also there was wrong selection of trees for particular sites. In many instances, black locust was planted on sites which are now known to be entirely unsuited to that species. The inevitable result was a poor survival and unsatisfactory growth. A few extreme mistakes were made, such as attempting to plant trees on sage-brush hillsides in the West where it was evident to anyone with the least appreciation of ecological factors that the planting was doomed to failure. In rare cases, black walnut was planted in swamps, or yellow poplar on thin, bare ridges. Then too, there were droughts; in the Great Plains grasshoppers are a sufficient alibi for all failures there even though the droughts are an adequate explanation. In spite of all handicaps, trees have survived better in the Plains region than any other vegetation. The foresters of the Soil Conservation Service have reason to congratulate themselves that the results of planting to date seem to be, on the whole, quite satisfactory.

[1]Main office of C.C.C. organization.

Table 1.—Results by States of the Soil Conservation Service Program of Planting Trees and Shrubs

1	2	3	4	5	6	7	8	9
				Satisfactory survival		Unsatisfactory survival		
State	Planted to date S.C.S. records	Examined and reported fiscal year 1937	Percentage of planted area examined	Acres	Ave. surviv.	Acres	Ave. surviv.	Percent of acres examined (7)÷(3)
	Acres	*Acres*			*Percent*		*Percent*	
Alabama	17,727	13,251	80	10,250	82	3,001	48	22.7
Arizona	6,754	4,896	73	3,228	53	1,668	17	34.
Arkansas	4,264	2,899.6	68	1,795.7	74.1	1,103.9	46.2	38.1
California	5,230	Incomplete report						
Colorado	4,269	3,900	91	967	55	2,933	23	75
Florida	1,296	1,354	102	1,110	86	244	69	18
Georgia	11,743	9,416	80	8,436	83	980	44	10.4
Idaho	330	345	104	318	76	27	36	8
Illinois	8,253	422	5	413	76	9	36	2
Indiana	7,539	2,899	38	2,221	83	678	49	23
Iowa	1,998	307	15.4	206	78	101	48	33
Kansas	1,672	591	35	210	73	381	26	64
Kentucky	7,839	3,210	41	2,204	80	1,006	58	31
Louisiana	5,795	2,556.6	44	1,937.7	81.9	618.9	37.3	24.2
Maine	112	82	73	82	89	----	----	0
Maryland	620	589	95	439	77	150	39	25
Michigan	127	119	94	110	81	9	64	8
Minnesota	5,817	785	13.5	473	69	312	45	40
Mississippi	16,272	6,399	39	5,075	82	1,324	56	20.7
Missouri	8,454	653	7.7	584	71	69	24	10
Montana	251	69	27	----	----	69	35	100
Nebraska	3,703	2,146	58	1,005	57	1,141	26	53
Nevada	1.289	No report						
New Jersey	1,105	843	76	568	79	275	35	33
New Mexico	7,234	2.365	33	1,629	48	736	12	31
New York	8,002	2,757	35	2,001	80	756	29	27
North Carolina	11,548	8,049	70	6,470	82	1,579	49	18.6
North Dakota	2,441	1,564	64	748	86	816	54	52
Ohio	11,819	3,587	30	2,457	84	1,130	46	31
Oklahoma	6.567	2,609	40	1,542	62	1,067	37	41
Oregon	316	96	30	72	65	24	21	25
Pennsylvania	8,236	4,163	50	2,571	76	1,592	35	38
South Carolina	13.157	12,722	97	11.354	81	1.368	61	11
South Dakota	2.197	1,265	57.6	500	80	765	51	60
Tennessee	3.744	797	21	768	88	29	61	4
Texas	3.232	1,484.4	45.9	680.6	62	803.8	28	54
Utah	185	84	45	80	47	4	14	5
Virginia	5,090	3,909	77	3.658	86	251	66	6.4
Vermont	120	186	155	50	74	136	36	73
Washington	887	660	75	580	59	80	48	12
West Virginia	6.046	4,637	77	1,874	77	2.763	33	60
Wisconsin	3.941	531	13.5	371	71	160	37	30
Wyoming	443	337	76	45	85	292	45	86
Total or average	217.664	109.534.6	50	79.083	78.4	30 451.6	39.4	27.9

The Planting Record

Trees and shrubs have been planted by the Soil Conservation Service since the spring of 1934. The total number planted to date in round numbers is 350 million, which includes the trees and shrubs in original plantings and the number used for subsequent replantings. A total of about 217,500 acres has been planted. This is an average of 1,600 per acre, which is less than might have been expected because on a great deal of gully and streambank planting a 2 by 2 or 4 by 4 spacing was used. Plantings as close as 4 by 4 were made on considerable areas of ordinary old fields in the early days by overenthusiastic foresters. The biologists usually use very close spacing when planting mixtures of trees and shrubs for the benefit of wildlife. In later plantings we are getting away from the close spacings; 6 by 6 is nearly standard now.

Approximately 20 percent of the total area was planted with shrubs, partly for food and cover for wildlife, partly as border plantings, and partly as understory to furnish a quick ground cover. The purpose of all the planting by the Soil Conservation Service is, of course, erosion control; the secondary purposes are the production of wood, the encouragement of wildlife, and protection from winds. The record for the fiscal year 1937 will serve to show the classification of plantings, according to number of trees and shrubs used, in broad groups: gullies 28 percent, fields 60 percent, windbreaks in the Great Plains 2 percent, wildlife plantings 10 percent.

Survival Count Methods

As previously mentioned, prior to last year, each project and camp forester made his count of survival in his own way, which usually varied from a 100 percent count of living trees and shrubs to a general look at the plantation with the conclusion that it should or should not be replanted. Last year a uniform method of securing the basic data was employed so that the results would be comparable, and so that the same degree of accuracy in appraising the results would be obtained. The method follows the principles of simple sampling and statistical methods worked out by mathematicians. The minimum standard of accuracy aimed at was a standard deviation of plus or minus 5. The exact survival percentage considered to be satisfactory varies with the number of trees planted per acre, with the amount of natural vegetative cover present, and with the condition of the soil itself, that is, the necessity of a quick cover. Generally, the average survival percentage considered to be satisfactory is about 70 percent. Because of the abandonment of many of the C.C.C. camps, it was impossible to get a survival count on all of the areas planted. However, the final records show that 50 percent of the total areas planted was actually sampled by the Soil Conservation Service foresters. The average survival to date (column 6 of Table 1) which, of course, includes the results of replanting, is 78.4 percent.

Table 1 shows the survival record by states. It is interesting to point out the difference between the actual survival percentage in the South and Southeast and in the rest of the country. The average survival, that is the average of the percentage of satisfactory and unsatisfactory survival given in Table 1 is 78 percent in the Southeast and only about 60 percent in the Northeast. In the Great Plains region where the planting is mostly to provide windbreaks and where conditions are far from favorable, the average survival is 46 percent. Three states stand out as near failures; Colorado, with over 4,000 acres planted, shows a survival of only 23 percent on three-fourths of this area, and on the other one-fourth, 55 percent of the plantings are living; Montana has only a small acreage planted, and all of it averages 35 percent living; Vermont, with a mere 120 acres planted, shows three-fourths of this area with only 36 percent survival and the rest with 74 percent or an average survival of 46 percent for the entire 120 acres. Maine, on the other hand, shows an average survival of 89 percent on about the same acreage planted. Among the states that show successful results, are Georgia, with nearly 12,000 acres planted, nine-tenths of which show 83 percent survival; South Carolina has 13,000 acres planted, nine-tenths of which show 81 percent survival; Tennessee has 3,700 acres planted, 96 percent of which shows 88 percent living.

Most of the conclusions which can be drawn from the record substantiate what experienced foresters have believed to be true, namely, that no forester can expect to carry out planting operations successfully on a very large scale without doing a very considerable amount of replanting. The average percentage of planted

area which shows an unsatisfactory survival is shown by groups of states in the following tabulation:

State	Average survival accepted as satisfactory	Average percentage of planted area which shows an unsatisfactory survival.
Alabama, Georgia, Mississippi, North Carolina, South Carolina, Virginia	80	20
Indiana, Kentucky, New York, Ohio, Pennsylvania	80	30
Iowa, Minnesota, Missouri, Wisconsin	70	30
Kansas, Nebraska, Oklahoma, South Dakota	65	50

Even in the Southeast, where conditions seem to be more favorable for tree planting than in other parts of the United States, 16 percent of the original area planted must be replanted.

Planting trees and shrubs, especially on the poor sites, which are so often the only places available to the forester, is an expensive method of getting tree growth established. Wherever natural reproduction is possible, planting should ordinarily not be considered. Long distance transportation of stock with its almost inevitable risks of heating, drying, or molding is a very frequent cause of poor plant survival. The more often stock is handled and the longer the time which elapses between nursery and planting site, the greater the risk of planting poor stock. The species for planting must be selected carefully in relation to the sites available, and it is wise to plant first on a small scale until the best methods of planting are determined, and until the results in terms of survival and growth are evident.

PRIVATE FORESTRY IN THE NORTHEASTERN STATES WITH SPECIAL REFERENCE TO NORTHERN NEW YORK[1]

By A. B. RECKNAGEL
University of British Columbia

The progress of industrial forestry in the Northeast is described and the possibilities for similar progress in the Northwest is discussed. The opinion is expressed that the opportunities for industrial forestry in the Northwest are outstanding.

AT THE annual meeting of the Society of American Foresters held in Syracuse last December, Forrest Colby[2] showed that the northern New England states have a sufficient supply of pulpwood of spruce and fir to last an average of 37 years and that by then another crop will be ready for harvest. In other words, New England has achieved sustained yield in the sense of continuous regional production of wood for stable permanent industries. It has attained the objective of the Conservation Code of 1934 "to provide without interruption or substantial reduction, raw material for industry and community support."

What of the other northeastern states—Connecticut, Rhode Island, New Jersey, and New York? In the first three, the forest area is relatively small and the problems, primarily those of farm woodlands, are being met adequately for the needs of those states. In New York with its larger area and diversified forest conditions the industrial timber region is confined chiefly to the "North Woods," that is, to the Adirondacks, and there the same situation of continuous regional production of wood crops prevails as in the northern New England states.

What has brought about this comparative

[1]Address delivered at the joint meeting of the Puget Sound and the Columbia River Sections of the Society of American Foresters, Pack Forest, La Grande, Wash., May 7, 1938.

[2]Colby, F. Industrial evolution and forest practice in the Northeast. Jour. Forestry 36:196-200. 1938.

stability? Is it purely fortuitous and, if not, are there any parallels to be drawn between the developments in the Northeast and those in the Northwest?

The first source of stability in the forests of the Northeast is the private ownership of the land. By far the major part of the timberlands in the Northeast is privately owned. The national forest area in New England is comparatively small. In New York it is nil. There are, it is true, state forests in New England, but these are comparatively unimportant. In New York nearly one-half the principal forest area is in state forest preserves, tightly locked against any but recreational uses by provisions in the state constitution.

These private owners, largely pulp and paper companies and lumber companies, are not actuated by "cut out and get out" motives. True, some of them are stripping and dumping their lands, but there is an innate conservatism in the "North Woods" operator which, together with a favorable combination of climate and species, has operated to keep the forest area producing trees, not a few large trees but many small, primarily pulpwood trees; and the economy of the pulp and paper industry is admirably adapted to just the kind of trees that can be grown best in the Northeast, namely: spruce, balsam fir, beech, birch, and maple.

The second reason for stability of forest land ownership lies in adequate provisions for protection against fire. It is hardly an exaggeration to say that, in terms of eastern Washington and Oregon or of Idaho, there is no forest fire problem in the Northeast. True, the "North Woods" had fires, and big ones too by the standards of the Northeast, but puny alongside the Tillamook burn. Today, the efficiency of the fire protective organization is such that fire is an unimportant factor in forest management. Unfortunately, this is not yet true of insects and fungi.

Complete utilization of the trees cut has played an important part in stabilizing the wood-using industries. This, of course, is exemplified by the pulp and paper industry. While some profess to believe that the pulp and paper industry has turned its back on the Northeast in favor of the South and the Northwest, it is my belief that there is ample room for an expanding pulp and paper industry in all three regions and that as long as eastern spruce is a premier pulpwood the growers thereof need not worry about markets.

The chief reason for stability in the forests of the Northeast is that the owners have grasped the idea that trees are a crop to be grown and not only a mine to be worked. They have got beyond the concept that virgin timber is the only forest resource and they have learned to value the second growth. Unless and until this viewpoint prevails on the Pacific Coast, very little progress is possible in industrial forestry in the Northwest.

The Northeast has been fortunate in not disposing of all its virgin timber until an approximately equal rate of cutting became possible in the second growth. This growth capacity is imperfectly known even today. Years ago, Dean Graves told my class at the Yale Forest School: "We know nothing about growth." That is as true today as it was then. However, we are now trying to find out something about growth.

Outstanding among the principal owners and operators in northern New York is Finch, Pruyn & Co., Inc., of Glens Falls. This company operates a newsprint mill producing approximately 150 tons daily. It requires about 35,000 cords of spruce and fir pulpwood annually to supply its stock of groundwood pulp. In 1911, 37 years ago, the company owned about 100,000 acres in the Adirondacks and that year it engaged Howard L. Churchill as its forester. The forest inventory made by Mr. Churchill showed that the area owned by the company could not supply 35,000 cords of spruce and fir on a sustained-yield basis. So the company purchased 40,000 acres of Canadian woodlands and from 1913 to 1928 its cut was chiefly from these lands.

In 1923, I was commissioned to make a growth study of the company's Adirondack lands which, by then, had doubled, approximating 200,000 acres. This study, the results of which were reported by George N. Ostrander, vice-president of the company, at the conference on commercial forestry held in 1927 under the auspices of the U. S. Chamber of Commerce, showed a capital growing stock of approximately one and one-half millions of cords of spruce and fir. The annual increment on this area was about thirty-five thousand cords yearly, sufficient to meet the needs of the mill.

This was in 1923. In 1937, 14 years later, Mr. Ostrander[3] stated: "Resuming cutting in New York State in 1928 at the rate of about 32,000 cords annually, we have since supplied practically all of the requirements of pulpwood for our mill from that source" (that is, the New York lands).

It is gratifying to point to such an example of sustained yield in operation. And silvicultural considerations have not been neglected. All trees are marked previous to cutting. As a general rule, no spruce under 8 inches d.b.h. and no fir under 7 inches d.b.h. is marked unless the condition of the particular trees makes their removal necessary. Also, larger trees are left standing where needed. Excellent cooperation with the U. S. Forest Service through the Northeastern Forest Experiment Station has resulted in a series of methods of cutting plots. These have been described elsewhere in the Journal.[4,5] The increment of spruce and fir has averaged 2.38 percent or one-fifth cord per acre annually.

It should not be forgotten that the company has backed its belief in forestry by the expenditure of hard cash. The forestry staff of two graduate foresters and a field crew of five (for marking and surveying) has averaged a cost of 25 cents per cord of wood cut. This cost is offset by the assured yield of pulpwood to the company on its own lands at such times and places as it desires to log. It is operating under a management plan, first prepared by Churchill in 1911, revised in 1923 and again on the basis of an intensive classification survey in 1930 and 1931.

I have cited Finch Pruyn's example at length, not because it is unique but because it is typical of what other private timberland owners are doing and have done in the Northeast, although not all with equal success. Last summer I made a growth study for the St. Regis Paper Company of their 200,000 acres in extreme northern New Hampshire, a veritable principality. The results of the study[6] corresponded closely with similar studies in the Adirondack region. More important still, there is substantial agreement among foresters in the Northeast that a current annual increment of 2 percent or better is a safe assumption for eastern spruce and balsam fir. This amounts to about one-fifth of a cord of wood per acre per year.

There is need throughout the Northeast of building up the growing stock. In part this will be achieved by the inherent recuperative capacity of the northeastern forests but it requires more than this; it requires the application of forestry practices to the land. Silviculture and management must join hands to attain the desired result.

Summary

The larger private forest owners in the Northeast are keenly aware of the possibilities of making and keeping their timberlands fully productive. So far as economic conditions permit, they are handling their lands on a basis of continuous forest production. Already the total annual growth is in excess of the total annual cut and will probably continue so. However, there is need of building up the capital growing stock in both quantity and quality. This is the task of forest management and silviculture.

It appears most likely that with the gradual diminution of the lumber industry and the increasing importance of the pulp and paper industry in the Pacific Northwest, timberland owners as well as foresters will overcome the "big sawlog complex" and become aware of the commercial possibilities inherent in the second growth. When that time comes, the Northeast will have to look to its laurels; for I am convinced that nowhere on the North American Continent—not even in the Southeast—are the opportunities for practicing industrial forestry greater than in the Pacific Northwest.

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[3] Ostrander, G. N. Jour. Forestry 36:178-179. 1938.

[4] Recknagel, A. B., H. L. Churchill, C. Heimburger, and M. Westveld. Experimental cutting of spruce and fir in the Adirondacks. Jour. Forestry 31:680-688. 1933.

[5] Recknagel, A. B. Five-year remeasurement of sample plots. Jour. Forestry 34:994-995. 1936.

[6] Recknagel, A. B. Growth of spruce and fir in northern New Hampshire. Jour. Forestry 35:1148-1149. 1937.

PROGRESS IN COMMUNITY FORESTS

By NELSON C. BROWN[1]
New York State College of Forestry

Some years ago considerable interest existed in the establishment and development of community forests. During more recent years there appears to have been a slump in this interest. It is extremely gratifying, therefore, that the U. S. Forest Service is attempting to revive interest in community forests. The following article by Professor Nelson C. Brown reviews the progress made to date in community forest development in the United States.

COMMUNITY forests are the most popular, profitable, and successful phase of the forestry program in many sections of Europe. They present a proud record of accomplishment. Some American foresters traveling through Europe have brought back impressions and some records from many of the Swiss, German, French, and other municipal forests abroad.

The success of the movement in Europe has had reverberations in this country. The idea has taken root. Community forests are definitely increasing in number, area, and in public favor in the United States.

There are many social and economic implications of significance in this program. As is true in Europe, community forests are making definite contributions to more stable community life. They furnish constructive and useful outlets for unemployed labor. They supply nearby recreational outlets for the low income family groups who have little time and less money for extended vacations or relaxation from the daily routine. Many of these forests are being used for arboreta as well as for bird and wild flower sanctuaries. Aesthetic treatment of the approaches or outskirts of our communities to make them more attractive, inviting, and appealing both to the residents and to visitors is becoming an important consideration. There are definite spiritual values recognized in community forests. All of these advantages are closely correlated with, but do not prejudice, the primary objectives of commercial profit. Timber crops for revenue have been the great motivating force behind the establishment and management of community forests in Europe.

There have been four definite eras in the development of community forests in this country which may be summarized as follows:

1. Exploratory or initial stages during which there were many magazine articles and much publicity as a result of European visits of foresters, public officials, and others interested in developments abroad.
2. A campaign of public enlightenment and education regarding the advantages of community forests. This may also be termed the promotional stage of the movement.
3. The period during which many laws appeared on our state statute books providing for their establishment as a direct result of public agitation of sentiment favorable to community forests.
4. Establishment and management. This phase is just coming into being.

Today we may witness the results of promotional and educational efforts carried on by state foresters, forestry associations, the federal government, and various forward looking and public spirited citizens and groups interested in the program. There is a warm human-interest story connected with the establishment of nearly every one of these forests. They have been acquired by gift, purchase, from tax reverted lands, and from town or county poor farms. In each state and in each community there have been definite guiding motives. Much credit should be given to those foresters who have furnished inspiration, enthusiasm, and good judgment in creating and managing these areas.

Although some community forests were established long before the national forestry program was started (first town forest was established in 1710 at Newington, N. H.) the movement is generally credited to Harris A. Reynolds of the Massachusetts Forest and Park Association who visited Europe and studied the subject in company with William P. Wharton of the American Forestry Association.

In New Hampshire, State Forester John H. Foster and Warren H. Hale have been active

[1]During the period February 1-September 15, 1938, the author was engaged in developing a program for community forests for the U. S. Forest Service.

and effective in stimulating the movement. In Vermont Perry H. Merrill has been the guiding spirit in the establishment of many of these forests and has done an effective piece of work in providing adequate plans for their maintenance and management. In New York, State Foresters C. R. Pettis and William G. Howard and Conservation Commissioners James S. Whipple, Alexander MacDonald, George D. Pratt, and Lithgow Osborne have been the motivating personalities in the establishment of some 579 community forests.

There are now known to be 1,352 community forests in New England, New York, Pennsylvania, and the two Lake States of Wisconsin and Michigan and the total area involved is probably about 3,000,000 acres.

Wisconsin has finally evolved what appears to be a satisfactory system for a most difficult social and economic condition confronting the people of its northern counties. Today there are 25 county forests comprising 1,746,647 acres and 149 school forests of 11,200 acres which vary from 40 to 320 acres in size. The C.C.C. has been most helpful in reforestation operations as well as in road construction, fire protection, stand improvement, and other work in carrying forward this program of Wisconsin county forests. Recently Frank G. Wilson has announced the appointment of 10 foresters for the management of these county forests.

Michigan has established a number of school and other types of community forests and the Department of Conservation recently has deeded 9,436 acres of land comprising 97 individual projects to municipalities to be used as community forests under the state law of 1931. There are 19 school forests established in Michigan.

New York has established 579 forests estimated to contain at least 150,000 acres on which 68,000,000 trees have been planted largely on abandoned farm lands of which there are 5,000,000 acres in that state. There are five different types of community forests in New York namely, county, township, city, village, and school district forests. Most of these community forests are of the village and school district types. The first and one of the most impressive is at Gloversville started in 1909 on which more than 750,000 trees have been planted on a watershed forest of about 3,000 acres. There are several counties and cities in New York which have planted from 500,000 up to more than 3,000,000 trees each. New York City has planted more than 5½ million trees on its Ashokan, Gilboa, Croton, and other watersheds. The city of Little Falls, N. Y., has received a cash revenue of more than $29,000 from the sale of timber products without impairing the growing condition and productive capacity of the forest. Meanwhile, the city has planted more than 2½ million trees, starting in 1916. These are storing up definite timber values for the future.

Under the guiding genius of Harris Reynolds who has written much of interest about the Massachusetts town forests, that state has at least 177 community forests of which 102 are town forests aggregating 32,000 acres. There are 75 watershed forests not organized under the Town Forest Act comprising about 83,800 acres so the total acreage in community forests in that state totals 115,800 acres. In addition, the Metropolitan Water District of Boston has recently acquired 54,000 acres of watershed lands. The size of the average town forest in Massachusetts is about 320 acres.

Vermont has established 44 community forests. Among them are some of the best managed community forests in the United States. At Essex Junction, a tract of 800 acres was acquired at a cost of $10,000. This initial investment has been entirely liquidated by the sale of timber products from which a net income of $13,000 was received. Thus a profit of $3,000 has been secured. There is a distinct series of age classifications and types, adequate fire protection assured, roadway construction, pruning, thinning, and stand improvement which gives it every appearance of a typical European community forest. Rutland has a very successful community forest of about 4,000 acres on which several million trees have been planted and from which more than 10,000 cords of wood have been cut and distributed to needy families on relief. Several thousand dollars cash income have also been received from the sale of cordwood, sawlogs, and pulpwood stumpage. It has a very complete forest management plan made by State Forester Perry Merrill.

Pennsylvania has 134 community forests of various types including watershed, borough, city, village, and county forests aggregating about 50,000 acres on which more than 5,000,000 trees have been planted. Reading, York, Lock Haven, and Franklin present impressive

examples of what may be done with community forests.

Maine has about 25 community forests, 8 of them organized as town forests and the balance are municipal forests with a total of 2,000 acres.

New Hampshire has a notable and impressive record. Here is located the oldest community forest established in 1710 at Newington. This little forest of 112 acres has played an important part in the social and economic life of this little village of 381 souls. From this forest, construction materials have been furnished for building the church, the oldest in continuous use in the United States, the school house, parsonage, town hall, and the familiar sheds of the old horse and buggy days. This little forest has helped to pay the salary of the minister of the church, has yielded revenues to pay off the Civil War debt, and has provided funds to pay for the village library; also enough money to put in a town water supply system has been secured from the forest. The forest completely surrounds that part of the village on which the public buildings are located. Part of it is also used as a baseball field and recreational center for both the young and old folks. The forest has been more than self-supporting as it has yielded over $6,000 in cash revenues in addition to supplying about 30 cords of wood per annum for heating the school, church, parsonage, town hall, and library. Thus this forest has played a significant part in the social and economic life of this little New England village.

New Hampshire has 102 community forests of which 91 are town forests and 11 are watershed forests. More than 2,000,000 trees have been planted on them. Of the town forests 31 were acquired by purchase, 30 by gift, 7 by tax title and 5 from unallotted land on common ground. Manchester has a water works forest of 3,482 acres, employs a professionally trained forester and is following an excellent management plan made in 1937.

New Jersey has a few community forests, the most notable of which is at Newark which has 36,000 acres and which employs a professionally trained forester. An equivalent value of more than $17,000 revenue has already been obtained from the sale of timber crops from this forest locally known as the Pequannock Watershed Forest.

Connecticut has made a modest start in community forests and the most notable is the Eli Whitney Forest belonging to the water company of New Haven, Conn. This company operates under a franchise from the city and is therefore a quasi-public enterprise. This forest has been under systematic forest management by Prof. R. C. Hawley of the Yale School of Forestry for 30 years and has definitely demonstrated the profitability of forestry as a business enterprise. About $43,000 profit has been received from the management of the natural stands which started with a very poor and almost valueless growth. Meanwhile many lands have been planted which are building up a definite value for the future. No thinnings are made unless they yield a profit. An interesting feature of this forest is that under Mr. Hawley's direction 150,000 board feet of white pine lumber has been cut from the thinnings on a 26-year-old plantation. The yield was from 500 to 1,800 board feet per acre and although the boards are largely 3 to 6 inches wide and generally in short lengths or 2 inches by 4 inches or 2 inches by 6 inches dimension this operation yielded a net profit of $3 per M.b.f. above all logging, sawing, marketing and overhead expense.

Some progress has also been made in several other states, notably in Ohio, North Carolina, Georgia, Maryland, Washington, Oregon, and California.

It is estimated that there are probably about 1,600 community forests in the initial or early stages of development. They occupy about 3,500,000 acres and already 146,000,000 trees have been planted on them. There should be at least 10,000 community forests in the United States. They have many distinct and definite advantages over state or federal forests. Due to their proximity they furnish quick and nearby outlets for recreation and, similarly, immediate or nearby markets for the sale of cordwood, sawlogs, pulpwood, poles, posts, piling, grape stakes, and other forms of timber products.

They also offer definite outlets for the employment of some of the more active and experienced forestry graduates who may handle these properties as a business enterprise with their multiple benefits that may be secured from them. Already there are about 40 trained foresters employed on these forests. Among them may be mentioned Manchester, N. H.; Gloversville, Rochester, Albany and Little Falls, N. Y.; Newark, N. J.; and Seattle, Wash.

Twelve county foresters were appointed in 1938 in Wisconsin.

Many foresters have acted in a supervisory or official capacity such as Prof. A. C. Cline, who is chairman of the Town Forest Committee of Petersham, Mass., Henry Baldwin who is on the Town Forest Committee of Hillsboro, N. H., Prof. K. W. Woodward, and L. C. Swain who have been active with community forests in and about Durham, N. H., and Prof. G. B. MacDonald of Iowa State College in the recent establishment of a community forest at Corydon, Iowa.

The community forest movement is being directed and guided generally by state foresters. Owing to insufficiency of funds and personnel many of these forests are in serious need of a definite management plan with thinnings, improvement cuttings, releasing, and pruning. This is particularly true in forest plantations of the Northeast.

There is every evidence to indicate that the community forest program is making distinct progress in the United States. A modest start has been made. It is a seriously neglected phase of the public ownership program of American forestry. A few foresters here and there have been outstanding in their leadership, forward looking vision, and enthusiasm in "selling this idea" to local officials, watershed engineers, and city fathers. It has been done in case of about 1,600 examples. The opportunity is at hand. It is hoped that more foresters will catch the vision of this movement and help in carrying forward a more constructive and notable record of achievement. This program is going through the same vicissitudes of fortune which marked the development of the program in Europe. It is a notable fact, however, that not one forest already established has been abandoned except in a few cases where some forms of community forests have been taken over as part of an enlarged park system or to be added to an already established state forest program.

SOME NEW ASPECTS OF SEED CERTIFICATION[1]

By HENRY I. BALDWIN
New Hampshire Forestry and Recreation Department

Progress in forest tree seed certification in other countries has come only after a continuous and prolonged campaign. Although it might appear, at first blush, to be a relatively simple problem to develop an effective program of seed certification, it is, in reality, a very complex problem. If we are to make any real progress in seed certification in America, foresters must have accurate information concerning its possibilities and objectives. The following article by Dr. Baldwin and the comments on this article by Messrs. Littlefield and Shirley furnish much of this information, in answer to requests made at the 1937 Annual Meeting.

The conference on seed certification held at Syracuse, N. Y. on December 18, 1937, in connection with the annual meeting of the Society indicated that foresters connected with reforestation projects are aware of the significance of seed origin, but there appears to be some confusion as to what is meant by "certification," the reasons for it, and how it can become more widespread.

Certification means "making certain, affirming, assuring," and the furnishing of a certificate, stating that certain things are true. There are many common examples of certification. The Underwriters Laboratories' tests of electrical and fire-preventive equipment are to insure the quality and appropriate design and use of electrical and mechanical devices. The certification of food and of chemicals is to prevent the substitution of inferior articles, apparently giving better value for the money, but cheapened by adulteration or undesirable economies in manufacture. The certification of animals—cattle, horses, dogs—is to insure that they are as represented and that the progeny will carry the desired inheritable qualities. Certification merely means the furnishing of a certificate which affirms that certain things are true. Certification is then only as good as the

[1]Acknowledgment is made to Doctors P. R. Gast and H. L. Shirley and E. W. Littlefield who criticized the original Ms. and made many valuable suggestions.

word, authority, or reliability of the person or agency furnishing the certificate.

Many states as well as the Seed Verification Service of the U. S. Department of Agriculture certify grain seeds. In most European countries tree seeds are certified by public agencies. Some American tree seed dealers certify their own seed, or offer seeds certified by foreign governments.

Why, then all this certification? Obviously it must have originated, and continues today because of the support of producers or consumers of these articles who recognize its benefits. The producers feel they are raising the standards of their product, and protecting themselves against competition of inferior goods; the consumers believe they can be more certain of getting a quality product if it is certified. In order for certification to be adopted there is generally the fear of, or actual chance of inferior articles becoming confused with safer or better articles, or of unlabelled and unknown goods being used inappropriately.

The basis, if any, for tree seed certification will be examined briefly. If sound and judged worth the candle, then both seed dealers and consumers ought to favor certification for their own protection.

The usefulness of certification varies. As will be noted, the usefulness of the statements concerning seed obtained from plantations is not as great as the usefulness of statements concerning seed from trees perpetuated in a given locality by natural reproduction. For these reasons the basis for the certificate of seed of native trees differs from the basis for the certificate furnished with seed of foreign trees.

Thus it would appear that the seeds of natural local races, descendents of the virgin stands on the same site, constitute a fairly clearcut material which can be identified by a certificate describing the climate of the site. However, seed is often obtained from stands to which this description does not apply. These constitute additional categories of "native" tree seed, and it is necessary to go into some detail to characterize the various possibilities.

Native Tree Seed

The evidence of racial differences in indigenous American trees continues to accumulate at a rapid rate. Differences in pitch pine have been found in New York State which justify keeping the different origins carefully separated. Observations are continually being made on red or Norway pine which confirm the findings of Bates that this species has different characteristics in different parts of its wide range. Douglas fir, ponderosa pine, and other western tree species are already often separated by collectors in various climatic and altitudinal zones.

Native tree seed might be thought to include: (a) seed of indigenous trees collected from natural stands of indigenous races, the result of natural reproduction; (b) seed of indigenous trees collected from planted stands, raised from seed originating near the planting site (local origin), far from the planting site (remote origin), and also seed collected in other regions of this country from "naturalized" stock of the species; and (c) seed of indigenous trees collected abroad. A fourth class might be included, namely: (d) seed of exotics collected from plantations growing in America or from volunteers escaped from such plantations. This might well be called native or domestic tree seed, in distinction to imported seed. Thus the answer to the question—what "native tree seed" shall be certified—is not simple.

The basis for the certification of the first category (a) from indigenous races, naturally reproduced, would be proof that the stands are of natural origin and that the seeds were collected in a certain area. The degree of detail necessary in describing the place of collection would depend upon the narrowness of the zoning required. At present, the name of the county and state where the seed was collected, together with the altitude and date of collection, seem adequate.

Certification of the seeds of the other categories presents difficult problems. If the origins of the stands are known and the stands are sufficiently large to guarantee homogeneous seed, then the certificates would not be much different from the first category; but such instances are infrequent. Seed collected from plantations will mostly be of unknown origin, often from a distant source. Further, the seed from small plantations may be genetically a mixture of the inherited quality of the local race confounded with the inherited quality of the introduced race, due to cross pollination. In such a case some of the trees raised from

such seed may be expected to contain individuals exhibiting characteristics of both the native trees, and of the planted stock. If the plantation is old enough to offer conclusive evidence that it is well adapted to the climate, or if it has developed as well or better than native trees, there seems no reason for objecting to the use of the seed in practice, but it *cannot rightly be certified as typical seed from that locality*.

A considerable quantity of seed of American trees like white pine, black locust, and white spruce is imported into this country from Europe where it has been collected from stands of these species which have originated either directly from seed shipped from America, or the descendents of such seed. American trees began to be grown in Europe from 100 to 200 years ago, and many species are thoroughly naturalized like black locust in Hungary and white spruce in Denmark, and bear abundant crops of seed. Sixty percent of all conifers in Denmark are exotics. Seed collecting activities are generally better established and cheaper in Europe, hence seeds of these species can be imported into the United States and Canada and sold in competition with local seed. Such seed perhaps should not be included under native tree seed, but it is the seed of native trees, and is sold by dealers without stating it was collected abroad. It cannot be certified as American seed, but if its inheritance is satisfactory it may be quite all right to use in certain regions. But the fact remains that we do not know, and as yet have no facilities for finding out if it is safe to use. There is obviously a need to label this seed as of uncertain origin, but otherwise it may be accepted as equal in merit to strictly American seed of unknown origin.

Exotics growing in this country constitute a parallel case. If they have proven their worth by satisfactory growth, by showing a capacity for resisting insects and fungi and by adapting themselves to the climate of the planting site, they are the safest, but *not necessarily the best*, source of seed of the species for additional plantings *on the same site* and near vicinity. Certification of such seed can go no further unless absolutely certain details are known of the origin of the parent stock. In the latter case, unhappily rare as yet, both the origin of the parent trees, and their location in America may be given on the label. One cannot yet be certain but it seems reasonable to assume that the seed will behave essentially the same as that collected directly from the source of the parents.

Combinations of these four classes are possible, and suggest the care which must be used if certification is to mean anything. At best we can certify usually one parent only. As planted stands become more and more mixed with native stock and as they grow to seed-bearing age the question becomes more complex. For this very reason *certification becomes much more necessary if we are to continue to obtain good seed*. The pedigree of the plantations used as a source of seed are absolutely indispensable.

Foreign Seed

The same subdivisions may be made for seed of exotics collected abroad as in the case of native seed. It should be remembered that mixtures of races and other complexities have gone very much farther abroad with one to two hundred years of artificial reforestation and shifting of seeds of the same species from one region to another. As a result of historical research this intermingling of races recently has been found much more widespread in Germany than heretofore suspected, and in some cases goes back to the middle ages. Furthermore Langlet has shown that tree races or strains represent an infinite series of gradual variations and intergradations rather than distinct types or varieties. All races are in transition, in process of adaptation to the site. No local race is homogeneous, but as Schmidt has pointed out, is composed of some individuals more perfectly adapted to the site than others; in the long run they will win out, but so far natural selection is not complete. It is too soon after the ice age.

Now, how does this confusion of races affect certification of foreign seed? How from this babel can we extract useful information, if the seed is certified? This is exactly the question which is perplexing European foresters, and incidentally it is this situation that makes them so keen for certification. By analogy we might consider the composition of a human population in Hamburg, Germany. If a group of citizens of this city were to emigrate to America, they might conceivably not all be natives of that city; some would have been born in Bavaria; others may have descended

from parents from Bohemia; but mostly they would speak like natives of Hamburg. Others might have had one parent who was born in Sweden or Austria. They would all be good Germans, they would look like citizens of Hamburg, but their children in America might follow widely divergent paths. The comparison is perhaps not entirely apt, but it will serve to illustrate the difficulties which have beset the certification of stands in Germany. Not only is there confusion in tree races but there is perplexity among foresters.

Certification of Stands Not Equivalent to Certification of Progeny

When a purchaser buys certified seed what he is thinking of is the kind of trees which will grow from the seed. It is the quality of the future trees, their rate of growth, hardiness, and straightness of bole which interest the nurseryman or the forester. Actually he is interested in the seed in his hands, not the parent trees. If he selects seed from parent trees having those characteristics it is because he believes that the offspring of such trees will be equally desirable. They frequently are. This has been the basis of the widely heralded certification of stands in Germany, and the less carefully considered suggestions in this country about seed orchards. There has been much pompous talk; little careful study and experiment.

After elaborate selection of such stands in Germany it soon became evident that seeds from some of the straight stands did not always produce straight seedlings, even when there was no opportunity for cross-pollination with trees of inferior form. Suspicion was aroused that the stand, externally uniform was not so even genetically. Trees which were similar in phenotype (external character) were different in genotype (genetic constitution). Throughout the life of the stand foresters had carefully removed the less shapely trees with every recurring thinning until only straight specimens were left to meet the inspection of the certification board. Their progeny showed the mixed genetic characteristics of straightness, crookedness, etc.

Fortunately, during the past decade a method of evaluating the behavior of seed as to straight or crooked growth of the seedlings in later life has been developed by Prof. Werner Schmidt of Eberswalde. This consists essentially in measuring the phototropic behavior of 7-day seedlings when exposed to a standard dose of ultraviolet light under carefully controlled conditions. By this test seedlings from these thinned stands react the way the average heterozygous population should, and the test gives a clear indication whether the stand is of naturally straight race or merely pretends to be so, masquerading under the careful culture of foresters. The tens of thousands of such tests which have been made show conclusively that many stands in Germany formerly considered of indigenous race, are really transplanted races; that many certified stands of fine external appearance, are actually most unsuitable as a source of seed for planting in that locality, and that any tree or group of trees old enough to bear seed may be examined by this method, and a fairly close estimate made of the origin of the strain.

This examination of the internal characteristics of seed has opened up an entirely new field for certification, and thrown a different light on certification of seed by locality of origin only, in cases where artificial reforestation has been practiced. However, these tests are still limited in their results, and are not capable of telling the whole story.[2] Other characteristics such as disease resistance, rate of growth, branching habit, relative preference by insects, technical quality of wood produced, frost hardiness, etc., can only be guessed at from the character of the parents, or from progeny tests. Present day thought in Germany on seed certification postulates:

1. Certification of geographical origin of seed has meaning only *provided the parent trees are of proven indigenous race,* native to the site.

2. Proof of whether a stand is of indigenous race can be secured historically, and checked by laboratory test.

[2]Since this paper was written, correspondence with foresters and plant physiologists in Europe has confirmed the belief of many American foresters that such tests are still in their infancy, and possibly show only the phototropism of the young seedling, which may differ from that of the mature tree, etc. Broad differences between northern and southern seed can be determined. The utility of the method in practical use is still not clear, and is the subject of lively discussion in Germany. Cf. Goetz, H. Die Bedeutung der rassischen Ordnung im deutschen Wirtschaftswalde und der Streit um die Aufartung. Forstwiss. Centralbl. 59: 661-676; 693-703; 725-734, 1937; Langlet, O. Proveniensförsök med olika trädslag. Skogsvårdsför. Tidskr. 36:55-278, 1938.

3. Certification of seed from planted stands or stands of doubtful origin can only be valid after conclusive progeny tests (phototropic laboratory).

4. Data on the geographic location of such stands and silvicultural characteristics of the parent trees *are not enough* and *may be valueless.*

5. Resistance to disease, frost hardiness, branching habit, wood quality, and many other factors can be determined only by progeny tests.

Other European countries probably have not as many mixed races as Germany, but there are a great many planted stands in all parts of Europe where settlement is old and where the forests have been exploited. Every plantation should be viewed with suspicion as a source of seed of indigenous race. Many of these countries export seed certified as to place of collection, and the large European seed houses pass this on to American dealers and consumers as certified seed, which it is, but certified for what? A birth certificate is not enough. The family pedigree must be known.

There is a remote possibility that a sufficiently reliable technique can be worked out whereby the racial characteristics, and hence the source of recent plantations, too young for seed bearing, may be determined with fair accuracy. Preliminary experiments at the Fox Research Forest in 1937 substantiate the work of Langlet (who used vastly more extensive material) that autumn moisture content of the needles is a good indication of origin. Very carefully standardized tests will be necessary. More significant are the drought-resistance tests which have been made by the Lake States Forest Experiment Station.

What and When to Certify

What, then shall we certify? Origin, productiveness, timber quality, or race? Let us not despair, but consider the problem fairly and realistically, and work out a practical solution for both imported and domestic seeds. It ought to be obvious that some sort of label is necessary if we are to know what we are getting, and if the statement on the label is vouched for by an impartial authority like a state or the federal government, confidence will be increased. Granted that certification is desirable, what characteristics should be certified?

It is still not practicable to certify timber quality (and it may never be so) but some races can certainly be recommended for "cover" only and others for straight timber production. For instance there should be a legitimate place in our planting program (erosion control, decorative stock, etc.) for a fast-growing race of Scotch pine, although we can't be sure it will produce straight timber in America. Certification of the characteristics of the mother tree or of both parents if known, may sometimes give valuable information on the behavior of a race on a given site, even if the same result cannot be guaranteed on other sites.

Origin should be stated for all seeds, even if it cannot be taken as the final basis upon which to judge the seed. In 90 percent of the cases involving native or domestic seeds it will be a valid indication of race. It should always be required. One American dealer has already advertised the geographic origin of one lot, and listed another lot as "from plantations."

Quality of the seed itself should be certified by tests conducted by a state seed-testing station or a federal forest experiment station. Certificates of such seed tests should accompany all lots of seed sold or offered for sale. The test should include purity, character of impurities and other seeds, evidence of damage to seeds in cleaning, weight of 1,000 seeds and number of seeds per pound as well as germinative energy and capacity, percentage of empty seeds, and date of test.

The following outline summarizes the basis for seed certification:

I Certification of Origin: Place of Collection and Inheritance

Place of collection: County, state, and country; average altitude above sea level; date of collection and year of crop.

- A. Seed collected in the country where it is offered for sale, or use.
  - 1. Indigenous species.
    - a. Local race indigenous to the site where collected.

a. Naturally reproduced stands.
b. Planted stands.
b. Introduced race (so far chiefly plantations in America).
2. Exotic species of various races, chiefly plantations.
B. Seed collected in other countries and imported for sale or use.
1. Species indigenous to the country into which they are imported.
2. Exotics.
a. Local race indigenous to the site where collected.
a. Naturally reproduced stands.
b. Planted stands.
b. Introduced race.

II CERTIFICATION OF QUALITY

A. Purity.
1. Percent of pure seed of the species in question.
2. Percentage of impurities.
a. Inert matter.
b. Kind and amount of other seeds.
3. Percent of pure seed damaged externally in extraction and cleaning.
B. Weight.
1. Weight of 1,000 clean seed.
2. Number of seeds per pound.
C. Germination.
1. Germinative energy. Percentage of seed germinated normally in a standard number of days. (See energy periods adopted for each species by International Seed Testing Ass'n.)
2. Germinative capacity. Percentage of seed germinated during duration of test.
a. Percentage of ungerminated sound seed (hard seed) as determined by final cutting test.
b. Percentage of decayed seed.
c. Percentage of empty or blind seed.
3. Date of test.

How Can Certification be Established in America?

Suggestions have been made for voluntary or cooperative certification by private associations of producers (seedsmen) and commercial nurserymen, such as exist in Holland.[3] It has been suggested that the Society of American Foresters should certify seed, but just how this could be accomplished even by numerous regional representatives, without excessive expense for travel and time is not yet evident. Furthermore it would be next to impossible to pass upon every foreign importation. State laws requiring every lot of seed sold to bear a label giving the place of collection and a certificate of quality would help, just as federal Quarantine No. 37 demands place of collection to be shown on imported seed. First a concerted demand from foresters and other users of tree seeds must make itself felt.

Foresters must help.—Failures to keep records of source of seed through nursery operations to the plantation (cf. Report of International Committee on Seed Certification, Jour. Forestry 36:166, 1938) reflects an apathy among some American foresters akin to that prevalent in Europe 30 to 50 years ago when large areas were planted with stock of unknown origin. No matter whence the seed came a record should be kept of origin, for even such empirical data may help later to demonstrate what to use and what not to.

Separation of seeds differing widely in source

[3]See paper by Baldwin and Shirley in this JOURNAL 34:653-663, 1936.

is already being put into effect by federal agencies. The U. S. Forest Service is collecting shortleaf pine seed in the South for planting not more than 25 miles from the point of collection, and on sites differing not more than 300 feet in altitude. In Region 6 Douglas fir seed of high and low altitudes are kept separate. Other examples might be mentioned.

Purchase of large quantities of seed is frequently made by purchasing agents who are not foresters, and who are striving to get seed of the species required at the cheapest price possible. They in turn receive requisitions from harassed administrative officials, trying conscientiously to keep within a budget, and forced by conditions to live for the day, to make decisions which are most expedient for the present and near future. They may be thoroughly conversant with the importance of origin of seed, and eager to work for the best forestry, but they are overwhelmed by more pressing matters. Finally there is the nurseryman, usually glad to get seed wherever it can be obtained in years of bad crops.

Costs of certification.—Canvassing the thirty-odd foresters attending the conference on certification at Syracuse, it was estimated that the cost of seed amounted to about 5 to 10 percent of the total cost of raising planting stock, certainly not over 20 percent. An increase in seed cost of even 30 to 50 percent would thus not increase the cost of stock noticeably, but there is no good reason why such a large increase should be necessary were certification applied on a large scale. Some seedsmen apparently think that certification means hand-picking cones from tall standing trees compared with collecting on the ground from felled trees. In the previous paragraphs characteristics to be certified have been outlined. Certification of methods of collection is unimportant, provided the seed is ripe and the race, etc., is properly controlled. Testing germination and purity should entail a small fee charged the seedsman, the bulk of the expense being borne by the state or federal agency maintaining the station. This form of certification is so obviously practical there is no longer excuse for tolerating the sale of untested seed. Certification of origin is of chief importance, and no evidence has yet been presented to show why this should involve any notable expense.

Costs of certification by the voluntary associations in Holland were reported by van Dissel at the International Congress of Forestry in Budapest. The costs now for origin certification are 0.25 florins per kg. or about 5 cents per lb. Nursery stock also is certified as to origin at the rate of 0.04 florins per M for 1-0 stock and 0.06 fl. per M for 2-0 stock and 0.02 fl. per M for trees exchanged between two dealers. Certification of origin by the U. S. Seed Verification Service has cost the dealer only 3 cents per 100 lbs.

Summary

1. Certification of imported and home-grown forest tree seed has been considered in the light of recent information affecting the basis for such certification.

2. The seed itself and its promise of producing the type of plants desired is the only useful basis for certification. The purchaser is interested in certification of the parents *only in so far as it insures the quality of the progeny.*

3. Forest geneticists are not impressed by certification of one parent only. The answer is collection from local indigenous races only, where both parents are of the same race.

4. The collection of seed from planted or nonindigenous stands is discussed, and it is asserted that the certification of geographical origin alone of such seed is of questionable value.

5. The basis for certification of origin, race, purity, and germination is discussed, ways and means for its adoption in America pointed out.

6. The costs of certification and obstacles to its application are considered.

COMMENTS

By E. W. LITTLEFIELD
N. Y. State Conservation Department

After all the biological problems involved in seed certification have been solved, and after all foresters have admitted the desirability of seed certification, we still have to face the question: "What administrative machinery adaptable to American forestry and American business conditions can be set up for accomplishing that object." During the past year or two this writer has become increasingly favorable to the idea of the cooperative association as avoiding the evils both of unregulated competition and complete governmental domination. In such associations, consumer and producer interests tend to become increasingly identical and the spectre of the "police state" is largely removed.

By this I do not mean that governmental agencies cannot play a considerable part in the matter of seed certification. There is certainly no reason why the facilities already available in federal or state departments for scientific methods of seed testing should not be utilized to the fullest extent. Certain regulatory activities also, such as the import restrictions, quarantine regulations, etc., already in force, must necessarily be a governmental function. The point is, that the success of any program of seed certification will, in the long run, depend on the active and voluntary cooperation of those whose interests are most directly concerned, namely: the collectors, distributors, and users of forest tree seed.

A word of warning may be added on basing one's appraisal as to the racial characteristics of a given lot of trees merely from the appearance of a single plantation. We are still very much in the dark as to the influence of site and method of establishment on an exotic tree like Scotch pine. As an example, we have two plantations of this tree in New York, representing identical lots of trees raised from seed collected in 1923-24 by Baldwin in Sweden. The trees in one plantation, located in the northern Adirondacks, are entirely distinct as to growth rate, form and winter coloring from those in the other, which is located in the southern New York plateau just west of the Catskills. Without knowing the history of these two plantations, an observer would assume them to be of quite different origin.

COMMENTS

By HARDY L. SHIRLEY
Lake States Forest Experiment Station

Dr. Baldwin's article is an attempt to clarify questions raised at the conference on seed certification at the Syracuse meeting.

The section entitled "How can certification be established in America?" may need further elaboration. Though state and federal legislation may be desirable to secure uniformity of regulation, the writer questions whether we are ready for such action. Much progress can be made through voluntary action on the part of foresters, particularly by those in public employ. After foresters become fully acquainted with the technique of certification, they will be better qualified to decide whether legislation is needed and, if so, what type will be required.

There are two major reasons for this opinion. In the first place, neither American foresters nor their European colleagues have yet developed sufficiently reliable diagnostic criteria whereby the provenience of a given sample of seed may be determined with accuracy. The nearest approach has probably been made by Schmidt of Eberswalde, but his diagnoses are based upon the assumption that such traits as frost hardiness, palatability to insects, disease, and drought resistance, are genetically linked with phototropic behavior of 7-day-old seedlings—an assumption wholly unsubstantiated by experimental evidence. This method would appear to be particularly questionable in diagnosing genetically mixed progeny. We may conclude, therefore, that a certification law has no basis for enforcement other than the evidence which can be gleaned from records kept by seed handlers and nurserymen, backed by

infrequent inspection. In other words, the service is bound to break down unless it receives the wholehearted support of those engaged in collecting and distributing seed. The success attained by legal means in Germany and other European countries is dependent, first and foremost, upon the willing cooperation of the overwhelming majority of seedsmen and nurserymen. A voluntary service extending over 20 years preceded the recent compulsory service in Germany. Certification of origin of agricultural seed by the Seed Verification Service in Washington is entirely on a voluntary basis.

In the second place, as foresters we are concerned with forest planting, not with ornamental tree planting. Forest planting in the United States is primarily a public activity. Hence it is the policies of public foresters that are in greatest need of clarification. This is a matter for administrative ruling, rather than for legislation. Once the various federal, state, and other public agencies establish and enforce satisfactory certification of tree seed within their own organizations, private agencies are almost certain to fall into line. It is logical to look to the federal services for leadership in seed certification.

Forest planting by states receives financial assistance from the federal government, and even forest planting by farmers is subsidized, to a certain extent, by federal or state funds. Insistence upon use of seed certified as to origin might logically become a requirement for securing state or federal aid for planting.

It goes without saying that preliminary steps along this line should be made just as practicable and straightforward as possible. They should be directed, first, towards education of the administrative officers, and towards training a large number of responsible foresters, and all public nurserymen, in the task of certifying the seed and stock of their locality. By this means, no planting program, whether public or private, need be held up for lack of seed of known origin.

Private seed dealers and nurserymen naturally look askance at the prospect of additional regulatory measures to be enforced by a new public agency. Their confidence in the desirability of seed certification would be greatly strengthened provided the certifying agency were able to provide also official tests of purity and germination. Such a service requires the establishment of one or more laboratories specially equipped to cope with the problems of tree seed. The development of a satisfactory tree seed service should logically provide for a research program to accompany regulatory measures and routine tests, so that those engaged in handling tree seed may expect to profit by ever improving technique, as well as by standardization of product. However, the great importance to the nation of initiating promptly measures to prevent indiscriminate mixing of tree seed, justifies proceeding with preliminary control measures based on existing knowledge.

Responsibility for avoiding the costly and irremediable mistakes of Europe lies with every forester, not alone with those engaged in planting. Teachers of silviculture, forest administrators, and particularly foresters who have seen at first hand the disheartening results of indiscriminate transfer of tree seed in Europe, owe it to their profession and to the public trust reposed in it, to insist that American forest plantations shall not be of uncertain parentage.

EFFECT OF INDOLEBUTYRIC ACID ON ROOTING OF GREENWOOD CUTTINGS OF SOME DECIDUOUS FOREST TREES

By MICHEL AFANASIEV

Northeastern Forest Experiment Station[1]

Treatments of cuttings of some deciduous trees with indolebutyric acid is shown to promote root development. The most effective single treatments, with respect to the concentration of acid and time, are given for gray birch, white birch, red maple, and white poplar hybrid.

ACCORDING to some investigators (*1, 8*) all plants have a potential ability to produce new roots and consequently every plant can be propagated by cuttings. The time required for root formation and the ability of a cutting to survive until new roots begin to function are two limiting factors determining the final outcome of any attempt to root cuttings. The attention of some investigators has been directed toward artificial means, both physical and chemical, of stimulating and hastening the process of root formation because keeping a cutting alive in many cases involves the maintenance of rather exact conditions for a considerable length of time. In recent years the studies of different phases of rooting have included arborescent species, and among these some of our common forest trees (*2, 5, 7, 8*).

Since the discovery of the effect of several indole derivatives on the initiation of root growth and further studies of the extraordinary properties of these substances (*4, 9, 10*), treatment of cuttings with indolebutyric acid stands out as a very promising means of inducing root formation in many plants that heretofore could not be reproduced in this manner.

This work is an extension of the investigation undertaken by the Northeastern Forest Experiment Station during the spring of 1937 (*6*) and aims at a study of the effect of indolebutyric acid on rooting of "greenwood" cuttings of some of our forest trees. The investigation was conducted at Frye, Maine, during the summer of 1937. All the cuttings were obtained within a radius of one mile of Frye.

Methods

The methods employed in the present investigation were essentially those used by Snow (*6*) on dormant cuttings, with such modifications as were necessary to adapt them to greenwood cuttings and to somewhat different growing conditions.

The leaf area on each cutting was reduced to one or two square inches by removal of several entire leaves and, in some cases, by clipping off a part of the remaining upper leaf. The terminal buds were cut off in all cases, but the lateral buds were left along the entire length of a cutting. The final cut at the basal end was made at an angle of about 45°. The length of cuttings ranged from 4 to 6 inches.

The treated cuttings were planted in a sand bed, at an angle of about 35°, with not less than three-fourths of the entire length of each cutting covered by sand. The sand bed consisted of a wooden frame laid on the ground and filled with river sand to a depth of 8 inches. The sand was kept moist and was shaded througout the summer with burlap stretched on frames and supported by lath. Attempts to shade with lath alone, spaced one inch apart, or with cheesecloth, resulted in the burning of leaves and excessive drying of the sand during the hot summer of 1937.

The standard set of treatments for each series of cuttings consisted of application of 4 concentrations of indolebutyric acid—5, 10, 20, and 40 mgs. of acid per liter—for period of 6, 12, 24, and 48 hours, a total of sixteen different treatments, with 4 additional lots used as controls, one for each time period. Each lot of cuttings receiving identical treatment was made up of 10, 20, or 25 individuals.

Results

Gray birch (*Betula populifolia*).—Two hundred cuttings of gray birch were treated and planted July 14-16 and examined twice during the summer, 2 and 10 weeks after planting. No roots were found on any of the cuttings at the time of the first examination. Eight weeks

[1]Maintained at New Haven, Conn., in cooperation with Yale University.

Fig. 1. A—Greenwood cuttings of gray birch treated for 6 hours with 5 mgs. of acid per liter. Photographed 11 weeks after treatment.

C. Greenwood cuttings of white birch treated for 12 hours with 5 mgs. of acid per liter, 11 weeks after planting. Note almost complete lack of callus.

later roots were found on 30 percent of cuttings treated for 6 hours with 5 or 10 mgs. of acid per liter (Fig. 1A) in contrast to 10 percent rootings of comparable controls. Treatments with 20 mgs. of acid per liter for 6 or 24 hours resulted in 10 percent rooting in each case. All other treatments as well as their controls gave negative results (Table 1).

The treatments of the second series (August 4-6) was confined to 3-, 6-, and 12-hour periods but in addition to the standard range of acid concentrations, included also those of 7, 5, 2, 1, and 0.5 mgs. of acid per liter. No roots were formed on any of these cuttings in 51 days.

From an analysis of the results of both series it appears that under the most effective treatment within the range tried, 8 or 9 weeks are required for initiation of root growth on gray birch cuttings.

White birch (*Betula papyrifera*).—Treatments of white birch cuttings (July 20-22) included practically the complete standard range of acid concentrations and time periods, and consisted of 17 lots, including 3 controls (Table 1). From 50 to 90 percent of the cuttings in individual lots died within 65 days. The mortality was highest in control lots and in those treated for 6 and 48 hours.

Practically every cutting which was still alive at the end of 65 days had formed roots. The treatment for 24 hours with a concentration of 20 mgs. acid per liter produced the highest percentage of rooted cuttings (50 percent), and also the longest and most abundant roots. Other effective treatments were: 5 mgs. of acid per liter for 12 hours (30 percent rooted), (Fig. 1 C) 5 or 10 mgs. for 24 hours (20 percent each), 5 mgs. for 48 hours, and 10 or 20 mgs. for 12 hours (10 percent each). An attempt to root cuttings of the two-year-old wood of white birch failed completely; all such cuttings were dead 65 days after planting (Table 1).

Sugar maple (*Acer saccharum*).—The cuttings of sugar maple were treated and planted July 21, 22, and 23. Besides 340 cuttings of

current year growth, handled in a standard manner, this series included also 160 cuttings from which all the leaves were removed and 160 cuttings of two-year-old twigs with and without leaves. Of the total of 660 cuttings, only one formed roots in the course of 63 days. This was of the current year's growth and had received a 47-hour treatment at a concentration of 10 mgs. acid per liter (Table 1).

Since 90 percent of these hard maple cuttings were still sound at the end of the investigation, there is a possibility that root formation would take place with a longer growing season.

Red maple (*Acer rubrum*).—The first treatment of red maple cuttings was made July 9 and 10, and consisted of the application of a full set of standard acid concentrations from 5 to 40 mgs. per liter for time periods of from 6 to 48 hours.

In the case of red maple, indolebutyric acid had a definite stimulating effect on rooting, which was particularly evident on cuttings treated with 20 and 40 mgs. of acid per liter (Table 1). Treatment with 20 mgs. of acid per liter for 24 hours gave the highest percentage of rooted cuttings (60 percent). Treatments with 20 mgs. of acid for 6 hours and 40 mgs. of acid for 24 hours resulted in 50 percent rooting in each case. Abundant and well-developed roots originating just above the basal cut or callus (Fig. 2) were formed with these treatments. Cuttings treated and planted August 4-5 were equally well rooted after 51 days (Table 1).

Treatment with 20 mgs. of acid per liter for 24 hours seemed to be the optimum for cuttings of red maple, since in both series this treatment resulted in the highest percentage of rooted cuttings, namely, 60 percent and 50 percent. Five percent of the control cuttings of the earlier planting rooted, whereas no roots were formed on any of the control cuttings of the later series.

Aspen (*Populus tremuloides*).—More than a thousand aspen cuttings, with and without leaves, were given the standard set of treatments. In addition concentrations of 1 and 2 mgs. of acid per liter, were also used. The cuttings were treated and planted on July 12-14

TABLE 1.—PERCENTAGE ROOTING OF GREENWOOD CUTTINGS TREATED WITH INDOLEBUTYRIC ACID

Species and date of treatment	Days after treatment	Time of treatment (hrs.)	Concentration of indolebutyric acid (mgs./liter)											
			0.5	1	2	5	7.5	10	15	20	30	40	80	Controls
			Percentage rooting											
		6	—	—	—	30	—	30	—	10	—	0	—	10
Gray birch	68	12	—	—	—	0	—	0	—	0	—	0	—	0
July 14-16		24	—	—	—	0	—	0	—	10	—	0	—	0
		40	—	—	—	0	—	0	—	0	—	0	—	0
		3	—	0	—	0	—	—	—	0	—	—	—	0
Gray birch	51	6	—	—	0	0	—	0	—	0	—	—	—	0
August 4-6		12	0	0	0	0	0	0	0	0	0	0	—	0
		24	—	—	—	0	—	—	—	—	—	—	—	0
		6	—	—	—	—	—	—	—	0	—	0	—	0
White birch	65	12	—	—	—	30	—	10	—	10	—	10	.	
July 20-21		24	—	—	—	20	—	20	—	50	—	0	—	0
Two-year-old wood		48	—	—	—	10	—	0	—	0	—	0	—	0
		24	—	—	—	0	—	0	—	0	—	0	—	0
		6	—	—	—	0	—	0	—	0	—	0	—	0
Red maple[1]	63	12	—	—	—	0	—	0	—	0	—	0	—	0
July 21-23		24	—	—	—	0	—	0	—	0	—	0	—	0
		47	—	—	—	0	—	10	—	0	—	0	—	0
		6	—	—	—	0	—	30	—	50	—	30	—	0
Red maple	77	13	—	—	—	10	—	0	—	10	—	20	—	0
July 9-10		24	—	—	—	0	—	0	—	60	—	50	—	20
		48	—	—	—	0	—	0	—	30	—	20	—	0
		6	—	—	—	—	—	0	—	24	—	40	28	0
Red maple	51	12	—	—	—	8	—	8	—	16	—	16	—	0
August 4-5		24	—	—	—	12	—	8	—	56	—	48	—	

[1]Cuttings without leaves, and those of two-year-old wood are omitted from the table. Both kinds received a full range of standard treatments, but none of these cuttings rooted in 63 days.

Fig. 2.—Red maple cuttings treated for 24 hours with 40 mgs. of acid per liter; photographed 11 weeks after treatment. Fifty percent of the cuttings rooted. Note well-developed root systems and practically complete absence of callus. No rooting occurred on any of the control cuttings.

and August 3-5.

Mortality was extremely high in both series, ranging in individual lots from 40 to 100 percent. Of the total number of cuttings only 3 formed roots. Two of these were treated for 48 hours—one with 10 mgs. and the other with 40 mgs. of acid. The third was untreated (Table 2).

The high and early mortality of aspen cuttings was apparently the result of some pathological cause. Soon after planting, the leaves began to turn black in spots, the discolored areas gradually extending to cover the whole leaf surface down to the base of petioles. An excess of moisture seemed to favor the development of the infection.

White poplar hybrid (*Populus alba p. nivea*).—The cuttings of this hybrid were obtained from a single tree and its root sucker. The latter was 18 feet high and 2 inches d.b.h. The material was collected, treated, and planted August 6 and 7. Wood of the current year, as well as of the preceding year's growth was included in this series. The treatments and their results are presented in Table 2.

In general, the higher concentrations of acid (20 and 40 mgs. per liter) proved to be the more effective. Treatment with 20 mgs. of acid for 12 hours resulted in the highest percentage of rooted cuttings—55 percent within 7 weeks. Cuttings of the second year wood also responded better to stronger treatments, although the highest percentage of rooted cuttings was only 33 percent. This was the result of a 24-hour treatment with 40 mgs. of acid per liter.

Table 2.—Percentage Rooting of Greenwood Cuttings Treated With Indolebutyric Acid

Species and date of treatment	Days after treatment	Time of treatment (hours)	Concentration of indolebutyric acid (mgs./liter)							
			1	2	5	10	20	40	80	Controls
						Percentage rooting				
Aspen July 12-14	17 and 73	6	---	---	0	0	0	0	---	0
		12	---	---	0	0	0	0	---	0
		24	---	---	0	0	0	0	---	0
		48	---	---	0	0	0	0	---	0
Aspen August 3-5	52	6	0	0	0	0	0	0	0	4
		12	0	0	0	0	0	0	---	0
		24			0	0	0	0	---	0
		48	---	---	0	4	0	4	0[2]	0
Hybrid poplar[1] (P. alba X P. nivea) Current year growth August 6-7	47	6	---	---	0-*10*	0-*50*	0-*50*	0-*30*	---	0
		12	---	---	*0*	0-*0*	10-55	*40*	---	*0*
		24	---	---	0	0	10	0	---	0
Hybrid poplar (P. alba X P. nivea) Two-year-old wood August 6-7	47	6	---	---	*0*	*0*	10-*0*	20-*30*	---	---
		12	---	---	30-*0*	*10*	30-*10*	*30*	---	*0*
		24	---	---	0	---	22	33	---	0

[1]Italic figures refer to cuttings from the root sucker, the others to cuttings from the parent tree.
[2]Concentration of 50 mgs./liter.

It should be added, however, that at the time of the examination several cuttings of the second year wood bore indications of their readiness to root in the near future. If the examination of these cuttings had been made a few days later, it is believed that the percentage of rooted cuttings treated for 12 hours with 10, 20, and 40 mgs. of acid (Table 2) would have been increased from 10, 20, and 30 percent to 30, 50, and 70 percent respectively.

Some response was evident throughout the whole range of treatment. Since no roots were formed on any of the control cuttings, the rooting of the poplar hybrid cuttings (Fig. 3) should be attributed entirely to the effect of acid treatments.

Summary

Definite indications of the effectiveness of indolebutyric acid in stimulating root growth were observed on cuttings of gray birch, white birch, red maple, and white poplar hybrid (*Populus alba* × *p. nivea*). Negative results were obtained with cuttings of aspen and hard maple.

Fig. 3.—Greenwood cuttings of the white poplar hybrid (*Populus alba x p. nivea*) 7 weeks after treatment with 10 mgs. of acid per liter for 6 hours. This treatment resulted in 50 percent rooting; no rooting occurred in the controls.

The most effective single treatment for individual species is shown in the following tabulation:

	—Treatment—		—Rooted—	
	Mgs. of acid/liter	Time (hours)	Percent	In days
Gray birch	5 or 10	6	30	68
White birch	20	24	50	65
Red maple	20	24	60	77
White poplar hybrid	20	12	55	47

The author believes that the percentages of rooted cuttings may be raised considerably with improvement in the technique of treatment and handling of cuttings.

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FOREST SOIL IN RELATION TO SILVICULTURE[1]

By SVEND O. HEIBERG
New York State College of Forestry

The biological and physical rather than the chemical characteristics of the forest soil are emphasized as of importance for productivity. The influence of various cutting methods, different species, slash disposal methods, grazing, and fire upon the forest soil is discussed and specific recommendations are made.

THE purpose of this paper is to consider some of the more important soil problems with which foresters have to deal. However, it must be remembered that forest soil science is very young and that the art of managing forest soils is in its infancy. Also, both soil problems and their solution—like silviculture—are local and vary with economic and ecological conditions.

The methods of managing forest soils are limited in number and must be confined, except in unusual cases, to extremely cheap measures. These methods are very different from those used in agriculture. Artificial cultivation and fertilization which are so important in agriculture can only be used, outside of the nursery, to a very limited extent. The chief methods available to influence the conditions of forest soils are: 1. method of cutting, 2. control of species, 3. slash disposal methods, 4. control of grazing, and 5. control of fire. Each of these methods will be dealt with separately, but first a few words will be said about forest soils in general.

A vertical cross section through normal forest soils can be divided into three broad zones or horizon as they are usually called. Closest to the surface is a humus layer consisting of more or less decomposed organic residues of the forest flora and fauna. Below the humus layer is the solum which is composed of that portion of the mineral soils which is strongly influenced by numerous weathering actions. The solum rests in turn upon the substratum which in most cases is similar to the basic material from which the solum has been derived.

Most of the tree roots are found in the humus layer and the solum, with the greatest concentration usually in the humus layer (*15, 13*). There is therefore reason to pay special attention to these two zones of the soil profile.

[1]Presented at the Annual Meeting of the Allegheny Section, Harrisburg, Pa., February 25, 1938.

About one-half the total annual production by weight of a forest consists of debris such as leaves, flowers, fruits, twigs, bark (*7*). This often amounts to one or more tons per acre per year. The debris is composed of organic compounds of which nitrogen, phosphorus, and calcium, some of the most significant nutrients for forest trees, are important parts. It is composed of elements which the trees in part have absorbed from the soil and which are now returned to the soil. This rotation of nutrients is very important for productivity. If the litter is removed by wind, fire, water, or other agencies, the soil will gradually deteriorate and equal growth can only be obtained by less exacting trees.

The continual removal of wood from forests is of relatively little importance because wood contains much less of the valuable nutrients than the litter. Any danger of exhausting the forest soil by removing wood and not substituting for the loss by artificial fertilization is far remote. If we figure out the amount of nutrient materials—with the exception of nitrogen and water—which are removed from the soil together with ordinary forest products and relate it to the content of nutrient materials in an average forest soil, it is found that there is no danger of soil exhaustion during one to fifty thousand years.

The productivity of the soil depends not only on the organic matter from the forest residue, but the way in which this debris decomposes is of equal importance (*15*). The type of the humus layer has a marked influence upon the productivity and other silvicultural characteristics of the forest soil.

Two distinct types of forest humus layers are commonly found in the humid forest regions. The names now generally accepted for these two types are mull and mor, which, furthermore, may be divided into several subtypes (*15, 19, 10*).

In the mull, the organic matter is intimately mixed with the upper few inches of the mineral soil. In its best form it is crumbly, friable, and porous. It resembles a well-cultivated garden soil. The mixing is done by the soil fauna, especially by the earthworms which continually dig and cultivate and eat both the vegetable matter and the mineral soil. The excreta are placed upon the soil surface; in fact, the entire humus layer of coarse mull consists of earthworm excreta. In good forest mull between one and two million earthworms are found per acre weighing about 800 pounds; their castings may amount to 15 tons per acre per year (*6, 22, 18*). There is no doubt that earthworms are the most beneficial animals in forestry. The cultivation of the soil and the plowing under of the manure which farmers and gardeners find to be of great importance for the soil productivity are done "free" by the earthworms if they are furnished with a suitable environment. Only little is known about the ecology of the earthworms. However, it is safe to say that they prefer a moist but not wet soil, sufficient organic matter, preferably from hardwoods, and moderate surface soil temperatures during the growing season (*15*). A coarse earthworm mull may be developed in connection with many different soil classes but mulls are less common on sands and unusual on coarse sands. Coarse mull is also seldom found in dry or in cold climates. It is more common under the better hardwoods in protected coves, but it can also occur under pure softwoods. I have found a coarse mull in pure spruce-balsam types at high elevations in the Appalachians, under redwoods in California, under coast Douglas fir in Oregon and British Columbia, and under pure white pine in New York State. With respect to productivity, this humus type is undoubtedly the highest and its ability to absorb moisture and thus prevent surface run-off and erosion is high. One liter of water poured on a 100 sq. cm. surface of a coarse mull—which corresponds to about 4 inches of rain—may be absorbed in less than 15 seconds, while on the same kind of soil where the coarse mull has not developed, it may require two to three hours to seep in (*3, 4, 1*).

The other main type of forest humus layer, the mor, is quite different from the mull. This also has several distinct subtypes, but its chief characteristic is the lack of incorporation of mineral soil. The organic matter is separated sharply from the lower horizon. The constant mixing of humus and mineral soil by earthworms does not take place in the humus type. Some species of earthworms live in the mor but they are not as active as in the mull. The entire fauna of the mor exceeds the fauna of the mull in number but it is much less active (*2*). The transformation of organic-bound nitrogen to ammonia, nitrate, and nitrites is slower in the mor and usually stops at ammonia (*11*). It is therefore necessary for the trees to depend primarily upon mycorrhizae for their supply of nitrogen and perhaps also for other important nutrients. (*8, 21, 14, 9*).

Mor is usually of a greater acidity than mull and the leaching of the upper part of the mineral soil is visible and pronounced (*15*). Mor is practically always found upon a typical podzol while mull is commonly found on a brown soil. Cold climates, poor drainage, dry sites, and sandy soils favor the development of a mor. Hardwoods often grow on a mor but conifers are much more common on this humus type. This is especially the case with spruce and hemlock. The tree roots always penetrate deeper into the mull than into the mor type. In mor they frequently remain in the humus layer and continue only to a limited extent into the mineral soil itself. Trees on thick mor sometimes stand almost entirely in their own residue. Windfalls are therefore more common on mor than on mull.

The fire hazard on a mull is only slight; in fact, the mull itself cannot burn due to its high content of mineral matter. Only the litter which is not yet incorporated may burn. The mor, on the other hand, creates a real fire hazard when it is dry. A thick mor absorbs moisture almost as readily as a coarse mull but a thin mor, only 1 or 2 inches thick, is easily saturated and the surface run-off is increased. This is particularly true where the soil is heavy because the mineral soil under a mor is compact. The growth and also often the form of the hardwoods are inferior to that found on coarse mull; and the growth of conifers on mor is usually also inferior to their growth on coarse mull.

Germination and early development of hardwoods are better on coarse mull than on the mor type, but it appears that certain conifers such as hemlock and spruce germinate and sur-

vive better on mor provided this is protected and moist.

All in all, the best mull type has silvicultural characteristics which are superior to the mor type. It is therefore desirable to handle the forest to protect and improve the mull and if possible to convert the mor into a mull or into the best possible mor type (*15*).

We shall now consider the influence of forestry practices on the soil. Heavy cuttings, approaching clear cuttings, have in most cases a detrimental effect on the soil. This is especially true when no advanced reproduction or underbrush protect the exposed soil and when the slash is disposed of in its entirety. The radical change in the local climate and the lack of new food cause earthworms of a coarse mull to disappear (*18*). The soil becomes firm and compact and in extreme cases sheet, gully, or wind erosion may set in and change a once fertile soil into a desert-like area which is very expensive to reforest. Only the least exacting species may be established on such poor sites. If the humus layer is a mor, clear cutting is usually also detrimental. The humus dries out and both the establishment and development of reproduction is hampered. The site is often taken over by undesirable, ericacious species which further the formation of mor and hold back the reproduction. Clear cutting a stand on a thick fibrous mor may be a benefit and cause at least temporary nitrification (*12*). This is the case in northern climates where the height of the sun is low and the effect of its direct radiation is small. However, this problem is of very small practical importance to forestry in the United States.

Light cuttings in fully stocked stands always seem to have a beneficial effect on the soil and improve all kinds of humus layers. The fauna in both the mull and the mor receives additional food in form of dead roots and moisture (*20*), and the increased light on the forest floor may also have a valuable effect. The slash which is left after such cuttings helps to retain the moisture and adds humus to the soil. Therefore, it should seldom be burned.

Cuttings on sites which are exposed to wind and sun should always be relatively light. Soil deterioration may easily set in on such areas and the damage may be difficult to remedy. On the other hand, soil deterioration does not easily take place on naturally good sites which have a protected location. Slight north slopes therefore do not suffer as much as south slopes from heavy cuttings and deep mull not as much as thin mull.

Another important way by which the soil may be influenced is by controlling the different tree species. Little, however, is as yet known about the exact value of each species in this respect. The mixed and the uneven-aged forest is undoubtedly the best forest form for the preservation and the improvement of the soil. The need for and the power of extracting nutrients from the soil is different for the various species (*16*). The demands upon the soil also vary for each species from period to period of the growing season (*17*). Mixed stands therefore utilize the soil better than pure stands. Also the leaves and other residue of the different trees are more or less beneficial to the soil and its fauna. The mixed forest offers a better "balanced diet" than the forest consisting of only one species. Although mixed stands may be considered the best forest form from a soil point of view, excellent soil conditions can very well be maintained in pure even-aged stands. This is especially true if these stands are thinned frequently so that the soil is enriched by the dead roots and slash. Even pure spruce, which generally is considered a soil degenerating species, can maintain good soil conditions if properly handled. When reforesting open land, much emphasis is often placed upon mixed stands. They have certain silvicultural advantages but artificial mixtures are difficult to make, and as a result there are too many examples of poor mixed stands where one species outgrew the other. For less money and effort a first-class pure stand might have been established. Compartments, 5 to 10 acres in size, with one species of the right provenance, adjusted to the site, thinned at the right time and at short intervals, do not endanger the silvicultural safety.

Conifers generally have a less beneficial influence on the soil than hardwoods. However, there are many exceptions to this rule. Douglas fir has an excellent effect on the soil, and it is also easy to create a good physical condition of the soil under eastern white pine and loblolly pine. It appears that the natural tendency for the formation of the root system of a species is of major importance for its influence on the soil. It is much more difficult to

create a good condition under surface-rooted than under deep-rooted trees. The nutrient content of the litter is of importance. The less exacting conifers have less valuable residue than the more exacting hardwoods (*16*), but the ability of a species to help create a good physical condition of the soil seems more significant. In this respect the deep-rooted species are superior to the surface-rooted species.

Slash has a beneficial effect upon the soil. It acts like a mulching paper upon a nursery bed, and in addition to its mulching effects it also adds organic matter to the soil. Its influence is therefore greater upon a soil deficient in humus than upon soils which are up to par. The reaction of young, stagnating stands to slash on worn-out, abandoned, agricultural land is surprisingly quick and striking. On the other hand, the effect of slash on thick, greasy or fibrous mor may be insignificant or even harmful. Unfortunately, slash may smother reproduction and in large amounts is a distinct fire hazard (*23*). From a soil point of view, however, the slash should be disposed of as little as possible. A light layer of slash may, in addition to its beneficial effect upon the soil, protect young reproduction from desiccation and from grazing damage and may also hold the snow in the spring and prevent frost heaving. On dry knolls and hilltops and on exposed slopes, it is of particular importance to leave the slash. The litter is often continually blown away on such areas and the soil is therefore, dry and deficient in humus. Slash will help to hold the litter and thus create a favorable microclimate which stimulates the soil fauna and the microorganisms which again increase the fertility of the soil. The fire hazard of slash, especially coniferous slash, is, in many places, so great that it must be burned even if the soil suffers. Although this is true, the value of slash to the soil must not be forgotten. It may often be the best method to leave the slash and use the money which would have been applied for its disposal for more efficient fire detection and suppression, and to close the areas of great hazard to the public.

Grazing is, in most cases, harmful to the soil. The animals, especially cattle, make the soil compact. However, the greatest damage is due to the continual removal of the reproduction and underbrush which protect the soil from exposure. An entire layer of the vegetation is removed if the grazing is heavy and regular draft channels or chimneys are created. A constant draft which has a distinct drying effect upon the soil may move through these channels. Grazing is, from several angles, one of the major problems of the farm woodland region. Its regulation will be a real contribution to better forestry.

A much disputed and controversial subject is the effect of fire upon the soil. A fire will burn part or all of the organic matter on top of the mineral soil. Ashes will seep into the soil and will be readily available for the plant life which survives the fire. A distinct stimulating effect will, for some years, be noticed upon the vegetation, but a fire does not add anything to the soil. The organic matter which, if it had been worked upon by earthworms, bacteria, or microfauna, would have released its nutritive products to the plants. But, due to burning the value is partly lost and the ashes easily washed away. The fire acted as a stimulant, with only temporary effect, but repeated usage of such practices will weaken the patient. A fire on a thick, fibrous or greasy mor may stimulate nitrification, at least temporarily, and may induce the desired reproduction if administered rightly (*12*). Many excellent softwood stands have originated this way, but, in general, fires are harmful to the soil just as they are to the forest.

Finally, I wish to say a few words about the reforestation of abandoned agricultural soils. Most of these soils are extremely poor in organic matter. They have been deprived of valuable nutrients; they have been made compact; and the soil fauna is gone (*2*). Even if some of these soils once supported exacting species, today only less exacting species can be used, such as most of the pines, spruces, larches, black locust, and red oak. They will build up the soil, and the fauna will return if it is enriched by slash and dead root systems from frequent light thinnings. Under the protection and in the humus of this first crop, more exacting species may develop. We find this in many of the older plantations in New York State where white ash, sugar maple, black cherry, yellow poplar, and other species seed in. Many failures in plantations on old fields are, of course, due to the extreme climate which now rules such open areas. Frost, wind, and sun have free play and are much more adverse

than inside the forest. A short cut to a good plantation may be to plant a nurse crop of intolerant hardy, fast-growing species, such as some of the pines, larches, birches, or aspen. When this is established and is 4 to 8 feet tall, the real crop should be planted. The life in the soil now begins to come back, and the nurse trees will protect the crop against the adverse influences of the climate and hold the snow in the spring, thus reducing frost heaving. This procedure sounds expensive but in many cases may prove to be the cheapest and the fastest way to a good forest.

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PITFALLS IN INTERPRETING LUMBER CONSUMPTION TRENDS

By FRANK J. HALLAUER
U. S. Forest Service

The trend in lumber consumption has worried many foresters. Some have even questioned the necessity of many forestry activities because they were afraid that eventually steel and concrete would so reduce the demand of lumber that a large surplus of this commodity would result. It is reassuring, therefore, to read that lumber consumption trend figures have been misinterpreted widely and that the actual per capita consumption of lumber is about the same as it was thirty years ago. There is a possibility of another upward trend in the lumber consumption curve with the probability of an eventual levelling off.

THE record of the trend in lumber consumption is very clear. The rapidly rising curve to 1906, the sharp turn, and the decline since then, are quite common knowledge. The change in trend appears even more pronounced if shown on a per capita basis, as in Figure 1.

The record is equally clear for cement and steel. It is common knowledge that consumption of these materials increased rapidly from 1909 to 1929 while lumber consumption declined just as rapidly.

This coincidence apparently simplified everything. Lumber presumably was being displaced by substitutes. Why? Because, coming from distant sources, it cost so much more than it did when it was produced nearer the market.

The case seems so clear, so complete, it has seldom been questioned; yet it is not true. That is, its implications are not true.

The extent and speed of the decline in the per capita consumption curve suggest that lumber is on its way out; that construction of dwellings and farm buildings must be quite different from what it was in 1907; that either we have found better materials or we are handicapped by a shortage of lumber. It seems incredible that these things may not be true, that the typical American house is still constructed of wood, that lumber is still the dominant farm building material, in fact that per capita consumption in these uses has not really changed much in spite of what the figures seem to show. It is all a question of what is meant by per capita consumption.

The per capita consumption of lumber has been determined in the past simply by dividing the total amount of lumber used annually by the total population. But, as a matter of fact, the lumber used in a building has not really been consumed and may not be for fifty or one hundred years. This factor would be of little consequence in our per capita figure if growth in population and expansion in agriculture had maintained their upward trend, but such is not the case, and the old per capita figure is no longer a safe index.

For example, lumber used for farm construction was estimated at 13 billion feet in 1910. An estimate of present normal consumption is about 6.5 billion feet. Since the farm population is about the same now as it was in 1910, per capita consumption on the farm would appear to have been cut in half, and the most likely inference is that lumber has been displaced to that extent by other materials. Cement floors, tile and cement silos, and steel tanks are now more widely used and do represent a displacement of lumber, but the difference between the 13 billion and the 6.5 billion board feet of lumber required annually for farm construction is accounted for primarily by the passing of the era of farm expansion. The number of farms increased by approximately 90,000 per year up to the decade ending 1910, and has since remained fairly constant. There has also been a replacement of farms with large buildings by smaller farms and farms in regions where smaller buildings are needed.

Let us look at it another way. Let us assume that farm buildings have a life of about fifty years. Assume that it takes 40 M feet of lumber to equip the average farm, and 2.5 percent of this amount for upkeep and replacement or 1 M feet per farm annually. For a farm family of five the per capita consumption would be 200 board feet annually, now the same as thirty years ago. The number of persons per farm is actually less now than it was thirty years ago and this loss will balance some displacement of lumber by other materials.

Urban housing presents a similar case. Some 25 percent of our urban population is now housed in multi-family structures, some fireproof, some with masonry walls, and most of them constructed with less lumber per family than the single family dwelling of a generation ago. But the majority of our houses are still single-family dwellings of frame construction. Hence the decline in the total amount of lumber used is mostly a matter of how many new houses are built. The average family unit today, including multi-family dwellings, is equivalent to 14,400 bd. ft. of lumber as compared with 17,000 bd. ft. a generation ago. The family unit is now 3.8 as compared with 4.3 for the earlier period, so that on a per capita basis the comparison (assuming a fifty-year life for the dwelling) would be about 80 bd. ft. per capita a generation ago to 76 bd. ft. per capita today.

The confusion in per capita data shows up also in the usual comparison of one state or region with another. For example, per capita consumption in 1928 was reported as 200 bd. ft. for Ohio and 1,108 bd. ft. for Washington. These figures are based on the assumption that lumber consumption is equal to production within the state, plus imports, less exports. But much of the lumber reported as consumed in Washington was made into boxes, doors, sash, and other mill work, then shipped and used elsewhere. For convenience, let us separate lumber consumption into two broad uses—construction consumption and factory consumption. Lumber used in construction can then be determined directly from construction records, and in this

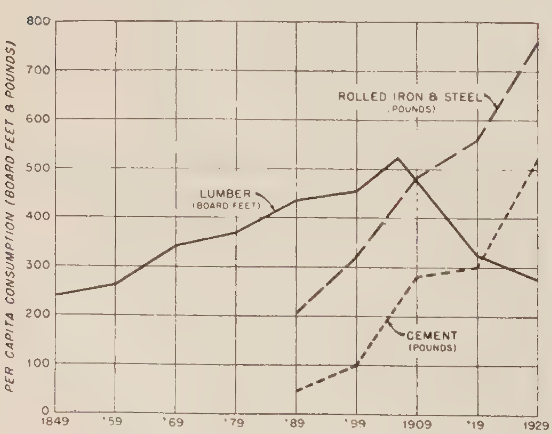

Fig. 1.—The per capita consumption of lumber in board feet, of rolled iron and steel, in pounds and of cement in pounds from 1849 to 1929.

way we find that for construction the per capita consumption was 250 bd. ft. in Washington as compared with 200 bd. ft. in Ohio. Of the difference, 20 bd. ft. are explained by the slightly higher proportion of masonry used in residential construction in Ohio, and 10 bd. ft. by the difference in the proportion of farm population, since the per capita use is higher for farm than for nonfarm groups. Significantly, the per capita farm consumption was approximately the same for both states—280 bd. ft.

The wide difference between the reported per capita consumption of 1,108 bd. ft. for Washington and 200 bd. ft. for Ohio is almost entirely in factory lumber. As a heavy producer of fruits and vegetables, Washington consumes a large proportion of the boxes she makes, which adds to her per capita consumption of lumber. But the lumber products that are shipped out for use elsewhere should not be credited to consumption in Washington.

Perhaps the last point can be made simpler by considering lumber used for motor vehicles and furniture in Michigan and Ohio, two adjoining states. The lumber consumed by motor and furniture plants in 1928 was equivalent to 112 bd. ft. per capita in Michigan and only 18 bd. ft. in Ohio, whereas the states are on a par in consumption of automobiles and furniture per capita.

The question may be asked, what difference does it make? It does not change the total amount of lumber used or the consumption trend. True. But it does make very important differences in our interpretation of the consumption trend and what can be done about it.

Obviously, if the average individual is using approximately the same amount of lumber for shelter today as was used a generation ago, the decline in total lumber consumption and in the reported per capita consumption is explained by the declining relative volume of construction as the expansion era came to an end. The decline, though abrupt, will stop at a level necessary to maintain and replace existing structures.

The farm has already reached that stage. Although nonfarm expansion will continue to slow down as population approaches stability, the amount of replacement will increase with the age of existing structures. One-half our urban dwellings are less than thirty years old, and replacement is small. Eventually replace-

ment should average over 400,000 to 450,000 dwellings annually, which is about what normal would be for new construction at present.

The per capita consumption of lumber in manufacturing since 1907 has followed a course similar to that in construction. Displacement of lumber in manufacturing is readily illustrated by the use of steel in mass production of motor vehicles, and by the use of fiber board for boxes. But indications are that the situation is approaching stability for lumber in manufacturing as well as in construction.

It is reasonable to expect, therefore, that the downward trend in per capita consumption of lumber since 1907 is not indicative of future trend. In fact the decline can stop as abruptly as the upward trend did in 1907.

On the other hand, an apparent per capita consumption of 1,100 bd. ft. for Washington is not a mark which other states can aim at. Pennsylvania imported doors, let us say, from Washington. Had they been manufactured locally it would have had little effect on the consumption of doors, because consumption was determined by volume of building construction, but it would have reduced the shipment of doors from Washington. Similarly, North Dakota could not have raised her per capita consumption of boxes to that of Washington, Oregon, or California by simply producing the boxes. She would have had to ship fruits and vegetables or other commodities requiring the boxes. Furthermore, it would not change per capita consumption of lumber in furniture if the furniture centers were shifted from Michigan and North Carolina to other states. Nor would a scattering of the industry, in order to give each state its proportionate share, be likely to change the amount of lumber consumed in furniture.

THE RELATION OF STAND COMPOSITION TO CROP SECURITY

REPORT OF THE COMMITTEE ON SILVICULTURE[1]

NEW ENGLAND SECTION, SOCIETY OF AMERICAN FORESTERS

The committee report points out that there are two schools of thought regarding the question of the relation of stand composition to crop security. One school believes foresters should attempt to copy nature. The other believes nature can be improved upon and that mixtures can be developed which are more profitable and safer than those occurring under natural conditions. The committee believes that the climax forest always should be used as guide to a workable combination of species but that modification of these may be made to yield the greatest return and still insure crop security. The committee report is followed by a statement prepared by Dr. J. S. Boyce, who indorses the pathological principles outlined in the report.

THIS report deals with certain aspects of stand composition, a subject which has not always received the attention it deserves, especially in view of present growing stock conditions in the New England region. Here are large areas of open or scrub-covered land which can be restocked only by planting, and still larger areas of volunteer mixed growth susceptible to various forms of silvicultural treatment in which questions of species to be favored constantly arise. Especially in southern New England temporary cover types now predominate to the practical exclusion of the more stable climax associations. On areas repeatedly exposed by clear cutting the light- and warmth-loving species are favored and the shade- and moisture-loving species characteristic of the old growth on the better soils are discouraged; short-lived species have gained at the expense of long-lived species, and weed species at the expense of those more desirable for crop production. Furthermore, much of the growing stock is young and in the formative period, when such composition control treatments as weeding and improvement cutting are especially beneficial. With such a large acreage in need of planting, complete or partial conversion, or some less drastic form of treatment involving composition, considerations of choice of species assume great importance. If, through fitness of the young stand to the

[1]W. R. Adams, E. S. Bryant, G. W. I. Creighton, H. I. Baldwin, A. W. Goodspeed, H. J. Lutz, L. C. Swain, M. Westveld, and A. C. Cline, *Chairman*. Presented at the annual winter meeting, New England Section, Springfield, Mass., March 8, 1938.

particular environment under which it is to be grown and through a composition secure against serious damage by insect pests and diseases, one can be reasonably assured of healthy and vigorous growth throughout a crop rotation, then questions of thinnings and reproduction cuttings may be solved quite readily in due course. First concern should be for the protection and security of the crop and the soil on which it is growing, and secondarily for the character and timing of intermediate and final cuttings. In growing wood crops we cannot afford the high costs of direct pest and disease control measures such as are increasingly resorted to in growing agricultural crops. We must depend largely upon developing resistant stands through silvicultural measures.

There can be no doubt that questions of protection loom large in the minds of forest owners, and that fear of fire, insect pests, and diseases is a serious deterrent to private forestry practice. At times it would seem that more publicity has been given the destructiveness of these agencies than the constructiveness of growing trees. It behooves foresters to clear up the present misunderstandings on the part of the public with regard to forest pests and diseases, and to see to it that forest protection measures are made an integral part of silviculture and forest management.

Generally speaking, there are two schools of thought regarding the question of the relation of stand composition to crop security. There are those who believe we should copy nature, and endeavor to establish stands having compositions similar to those of the virgin climax associations of two or three hundred years ago. They contend that powerful natural forces are constantly at work to bring about a readjustment of the whole climate-soil-vegetation complex, so violently disrupted by man, and that disregard for these forces will lead to all manner of difficulties in growing tree crops. There are others who hold that man can improve on nature and develop mixtures which will be both safer and more profitable than the original mixtures. There are still others who disregard the relation of composition to crop security altogether, and who are guided in their choice of species by expectable future needs of the market, presumably content to look hopefully to public agencies for the control of various pests and diseases. To be sure, this last-mentioned policy is far more common among laymen than foresters, and finds its origin in the days when forestry was considered as a sort of tree orcharding, when the owner decided what kind of trees he wanted to grow and then proceeded to plant them in uniform rows on whatever piece of ground was available for the purpose.

The consensus of opinion of this Committee is that the climax forest composition always should be used as a guide to a workable combination of species, but that, under present day conditions, modifications are needed in certain cases in order to assure the fullest value of composition in its relation to crop security. Present timber crops are not growing under the conditions which obtained in the virgin forests. The introduction of foreign insect pests and diseases is alone sufficient to make unsound any policy of rigidly copying the original forest composition. For example, the chestnut, for unknown centuries a prominent element in southern New England forests, has been eliminated by the chestnut blight (*Endothia parasitica*); and the beech, another important component of the northern forest climax associations, is being destroyed by the beech scale (*Cryptococcus fagi*) and the associated fungus (*Nectria sp.*). In Nova Scotia beech already is considered as good as gone, and in Maine heavy losses are expected in the future. It is to be strongly emphasized, however, that the forester should at all times be guided in so far as possible by an understanding of the composition and ecological relations of the climax forest for the particular locality in question. He should appreciate the character of the natural associations of plant organisms, and should follow natural tendencies unless he is reasonably sure that his information justifies departure therefrom. Cuttings aimed at reproducing stands should give full consideration to natural site potentialities and tendencies. Plantings likewise should be based on creating conditions of maximum stability and security consistent with the objectives of ownership. Even though such deterioration may have taken place in the soil, as a result of farming, repeated clear cuttings or fires, as to make impossible the immediate reestablishment of many of the valuable but exacting species which once occupied the site, we should plan on their gradual introduction as improved conditions of cover and soil permit.

There is abundant proof of the troubles

which ensue when the forester departs too far from the guidance of natural tendencies; when what may be called an artificial composition is created. Pure stands (monocultures) in particular, that is, on sites where pure stands never occurred naturally, have proved highly susceptible to attack by both insects and diseases. To quote Spaulding (*7*), "Extensive pure stands are especially liable to damage by disease because of optimum chance for an outbreak to build up and spread like a slow fire"; or Boyce (*2*), "It is axiomatic in crop production that intensive culture increases the danger from disease, and timber growing in western Europe is decidedly intensive. . . . Pure stands are the most susceptible to fungus and insect attacks, consequently much of the woodland in Great Britain, consisting of pure planted stands . . . , is inherently susceptible to disease." Hansbrough (*3*) is of the same opinion and states, "It is a generally accepted fact that any increase in the cultivation and production of any plant species is liable to be accompanied by an increase in the incidence of many parasitic diseases." Hansbrough might also have included insect pests. How well this natural law operates is illustrated by the extensive planting of pure white pine in southern New England and the attendant increase of the white pine weevil (*Pissodes strobi*) to the point where many plantations are now practically worthless except for box lumber. More recently we have seen the damage to pure red pine caused by the European pine shoot moth (*Rhyacionia buoliana*) in southern Connecticut, and by an as yet unnamed sawfly (*Neodiprion sp.*) in eastern Massachusetts. And Hansbrough (*3*), in his recent study of the tympanis canker (*Tympanis sp.*) finds still another danger in planting pure red pine, "especially outside of its optimum range, on unsuitable sites, or when of the wrong seed source."

A recent report on *Rust Canker Diseases of Southern Pine* (*6*) has brought to light the dangers of pure plantations of slash or loblolly pine, both highly susceptible to the rusts (*Cronartium cerebrum* and *C. fusiforme*) on land where the natural type is longleaf. This is another example of favoring a species largely on the basis of its market value (in this case for pulpwood) without due regard for ecological factors. Longleaf pine, which is the least susceptible to the rust, has been reduced through the control of fires and the popularity of slash pine planting to the point where slash pine has now been established beyond its natural range and on typical longleaf sites. It is reported that the rusts are increasing from year to year, and in some plantations upwards of 40 percent of the trees already are infected. Innumerable other cases might be cited to show the high risk of planting pure stands in localities and on sites where the species chosen did not naturally occur in pure stands before.

Heske (*4*) is his new book, *German Forestry*, says, "The abundant German experience with these monocultures is already of value as a lesson for the rest of the world. The lesson will become even more convincing in the future, as it becomes possible to demonstrate in specific instances what caused the frequent failures of the monocultures. These may have been due to pure stands as such, to the failure to adapt species to site, to the even-aged, schematic form of the forest, to other factors, or to the joint effect of several or all of these."

In addition to plantations, temporary cover types of natural origin composed of a single species, such as gray birch on old fields, aspen on burns, or coppice oak on areas repeatedly clear cut, are perhaps equally susceptible to injurious attack. To quote Spaulding (*7*), "There are areas where Nectria (canker) seriously damages one species. If the stand is heavily of this species, the stand is ruined..." Similarly, both aspen and gray birch stands suffer severe defoliation by the gypsy moth (*Porthetria dispar*) in the pine region, as does pure oak in the pine and oak region of Cape Cod. Pure white pine self-seeded on abandoned fields and pastures, a purely temporary type, suffered much greater damage from the white pine weevil than pine growing in stable associations on the same ground two hundred years before. In a like manner the white pine blister rust (*Cronartium ribicola*) is a very destructive disease where there are heavy concentrations of both white pine and Ribes. The conditions under which white pine generally occurred in the original climax associations, that is, in mixtures with hardwoods and other conifers, in all probability would be less favorable for the spread of the blister rust than the pure second-growth pine on old fields, or pure pine plantations.

However, a large proportion of the forested area of the region supports stands of volunteer origin which contain nearly all of their original

elements, but in which the proportions of the various species have been more or less modified through the activities of man. Here a wide choice exists in directing future composition. Since the Committee cannot hope to deal with all the varied conditions in the region, a few illustrative cases must suffice.

In Nova Scotia the loss of beech through the attack of the beech scale has considerably changed the original composition and will influence plans of silvicultural treatment. Unfortunately, the beech is being replaced largely by sugar maple, a species which in that part of its range is subject to black heart and is inferior to beech. On the other hand, in Maine it is expected that not only sugar maple, but yellow birch, spruce, fir, and hemlock will be increased as the beech drops out. In the former case composition control should aim to limit the increase in sugar maple and at the same time promote a well-balanced mixture of the other desirable species found naturally occurring together. But where the place of beech is taken by a fair representation of all its natural associates, no modification of the remaining mixture is indicated.

Throughout the northern forest balsam fir has shown inherently high susceptibility to both insects and fungi, and at the same time has increased greatly in abundance through its ability to reproduce prolifically following nearly every type of cutting. In Nova Scotia it now forms almost pure stands over extensive areas, and under such conditions it is severely attacked by the spruce bud worm (*Harmologa fumiferana*) and the balsam woolly aphid (*Adelges piceae*). Because of its high susceptibility to insects and disease, it may be desirable to reduce the proportion of fir to something approaching its occurrence in the original composition, or perhaps to a point below this level. But it would be a mistake to go too far in the direction of its elimination. For instance, the drastic weeding of fir in mixtures with spruce might have serious consequences, since, while such might be favorable from the standpoint of controlling the spruce budworm (which is most damaging in stands where fir predominates), it might subject the remaining spruce to the ravages of the European spruce sawfly (*Diprion polytomum*). When more is known about the habits of the sawfly and the extent of its destructiveness under various conditions of stand composition, more definite recommendations for composition control from the standpoint of crop security may be made. As yet it has not been definitely established that this insect is any more destructive in pure spruce than in mixtures.

In certain localities and on certain sites especially favorable for Ribes and where white pine originally was an element in the mixture, the prevalence of blister rust and the excessive costs of its eradication may make it no longer desirable to favor white pine. This is another case in which the introduction of a foreign disease has upset the former balance, between white pine and its natural associates, and exerted an influence on the choice of species in silvicultural treatments.

In southern New England continued depradations by the gypsy moth require some reduction in the proportion of oak, a genus well represented in the original forests, and today more abundant than ever before. Its increase has been due to several factors including the ability to grow comparatively well on deteriorated soils and exposed sites, the death of chestnut, and the reclaiming of second-growth pine land by hardwood. While it is doubtful whether oak originally formed pure stands, even in such places as Cape Cod, it may well have formed 50 percent or more of the foliage volume in mixed stands, a point beyond which heavy defoliation becomes possible. Security against this introduced insect pest through composition control should take the form of reducing the highly favored food species, notably oak (since grey birch and aspen usually are temporary elements in the mixture, and in any event inferior), to somewhat less than one-half of the stand. Here again it would be a mistake to cut all of the oak, because security against serious defoliation can be had without going to such an extreme, to say nothing of the certainty of upsetting the balance in some other direction. The greatest care should be taken in all composition corrections for insect and pest control purposes lest the treatment be too drastic.

While silviculturists, pathologists, and entomologists alike favor mixed stands of a variety of species on all sites where mixed stands naturally belong, there are large areas of open or scrub-covered land, areas of deteriorated soil and stands of low stocking where planting must be resorted to, and where there is no immediate prospect of establishing

the natural mixture which originally occupied the site, however desirable it may be. For instance, little success has attended efforts to establish mixed hardwoods on certain sites which once supported excellent stands of hardwood. And, since mixtures of conifers in many places offer the only solution at the moment, it is of interest to learn the Committee's opinion on this matter, more especially as regards the use of exotic conifers. Most of the Committee favor native species wherever possible and believe that in the long run they will be fully as profitable to grow as any others which may be introduced. Majority opinion holds that the planting of exotics should be considered as experimental only, until proven otherwise. They are to be encouraged only where there is good reason to believe they will succeed, and in this connection it is to be pointed out that the fast growth and excellent development of many exotics during the juvenile period is no reliable criterion of successful outcome. The Committee realizes at the same time that the only way to discover what will happen to introduced species is to try them, and among those most favored for continued trial are European larch and Norway spruce, in mixture with native conifers, of course. Both Ackers (*1*) and Hiley (*5*) have shown that European larch canker (*Dasycypha willkommii*) is more destructive in pure stands of this species than in mixtures, and Norway spruce is likewise much less subject to troubles when grown in mixtures. Incidentally, the European larch canker, which accidentally was brought into eastern Massachusetts nearly forty years ago, is now believed to be under control.

By way of enlarging the choice of species it is suggested that the use of double planting deserves more consideration. More varied and safer mixtures may be established by introducing some of the more exacting species beneath the partial shade and protection of the less exacting species planted a number of years in advance. Thus it may be feasible to plant hemlock or hardwoods in small openings cut in plantations of pine on land where these more exacting species would not succeed if set out directly under conditions of full exposure and deteriorated soil. This plan may be of service in speeding the restoration of the more stable associations recommended by the Committee.

Finally, mention should be made of the frequently expressed objection to composition based on that of climax associations because of the supposed inferiority of certain species. The Committee is in doubt as to the wisdom of attempting to draw a line between so-called desirable and undesirable species common to the climax associations. One member has this to say, "When produced as a quality product, white pine is one of the most valuable species grown in the region, but its economical production as a quality product may depend in a large measure upon its associates, chief among which is red maple, often classed as an inferior species." It seems not unlikely that a better knowledge of the part played by red maple in mixture with pine may give it an improved status, besides which, as pointed out by the Committee member, "red maple when produced as a quality product has relatively high market value, and lower grades have for many years found favor as fuel wood." In a like manner sweet birch may well gain a recognized place of importance in many stands. It is commonly associated with white pine and hemlock (in the climax types), its worth as lumber and fuel is moderately high, and it is favored as a food for grouse. In the case of red maple its bad reputation is due in a measure to its unsoundness when of stump sprout origin, a condition which does not necessarily apply to origin from seed or seedling sprouts. Furthermore, evidence points to the possibility of controlling Nectria canker, to which both red maple and sweet birch are subject under certain conditions, through restriction of high quality hardwood crop production to the better soils and less exposed situations, and by proper regulation of early density. Hemlock, a very common element in the climax associations of central and southern New England, is also frequently considered inferior; yet there was a time when this species, along with red spruce, was looked upon as very desirable for dimension lumber in building construction, and probably will be so considered again. There is need for much more information on the intrinsic worth of these so-called second-rate species when grown in managed stands, and of their ecological relations with their more valuable natural associates. On the basis of German experience Heske (*4*) concludes that "The foundation and the elements of practical silviculture are not the individual species of trees, but the natural life communities of which these eco-

nomically desirable tree species are a part. The growing of commercially less valuable, but biologically important, species in mixture with those of high economic value is equivalent to paying an insurance premium against later losses."

By way of conclusion the Committee recommends an increased use on the part of forest managers of the knowledge available in the fields of forest ecology, forest entomology, and forest pathology, and a closer cooperation with specialists in these fields to the end that the regulation of stand composition may contribute more surely and effectively to crop security and the upbuilding of healthy forests.

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COMMENTS

By J. S. Boyce
Yale University

FROM the standpoint of the forest pathologist the principles outlined in the foregoing report are eminently sound and timely. Among other things the Committee recommends caution in the use of exotic conifers, and this recommendation should be strongly emphasized. It is noteworthy that after more than two centuries of trial in Europe not a single introduced tree species has attained the commercial importance of native species, the most conspicuous failure being eastern white pine, which after extensive planting owing to its early promise has been largely abandoned because of white pine blister rust. The United States is fortunate in having a wide variety of conifers and hardwoods well adapted to the various forest regions so that there is little necessity for introducing exotics.

The introduction of an exotic is always beset with difficulties such as securing seed from the proper source, selecting suitable sites, and the reaction of the foreigner to native parasites. Seed from an improper source alone is certain to cause failure of artificial reproduction. Furthermore it is always questionable as to whether an exotic will be silviculturally and commercially desirable even on the best sites in its new environment. One of the vexing problems with exotics in Europe has been to secure adequate, natural reproduction.

Exotics are likely to be misleading. They may flourish vigorously at first and raise high hopes, only to fail dismally later after extensive plantations have been established. In fact the age of 20 to 30 years or more is often the critical period in the development of plantations of exotics and it is not until at least one rotation has passed that reasonable opinion can be formed as to the result of an introduction.

The range of a native tree can probably be somewhat extended with reasonable safety, but if the indigenous tree is carried too far outside its natural habitat it becomes essentially an exotic. It is noteworthy that Tympanis canker of red pine has occurred only outside the natural range of the host. When no topographic or apparent climatic barrier to the natural spread of a species has existed, it is not likely that its range can be much extended artificially with permanent success.

THE USE OF PHOTOELECTRIC CELLS FOR SAMPLING LIGHT IN FOREST STANDS

By ELMER M. BACON
University of California

Despite the fact that photoelectric cells have been utilized to a considerable extent in measuring light intensity in forest stands, the author believes that the use of a flat sensitive surface has resulted in a high degree of error due to variations in the angle of inclination. As a remedy for this a method is set forth embodying a sphere enclosing the cell as the sensitive unit. Results secured with this device are compared both as applied to hand sampling and to continuous recording.

IN physiological and silvical research, important consideration has been given to the measurement of solar radiation. Placing this complex physical phenomenon on a basis that will permit exact determination of its various effects has brought all manner of methods into play. These include the measurement of the heating effect of light as determined by thermopiles as employed by Burns, Gast, Shirley, and others (*2*), and also of the use of radio-atmometer developed by Livingston. The illuminating effect of light has been determined by spectrophotometers, and by illuminometers of the Macbeth type. Chemical effects of light also have been utilized in measurement, through the medium of sensitized materials. More recently, with the development of accurate photoelectric cells, measurement of light through its electrical effect has become feasible. These cells do not measure so-called total radiation, because they are sensitive only to wave lengths in visible and ultraviolet light. However, these wave lengths have been found to be the most important in plant processes, and are not subject to as great variations as other parts of the spectrum.

The data upon which this research is based were collected at the Connecticut State College in Storrs, Conn. Measurements were continued over a period from March through June 1937, under the guidance of Dr. Raymond Wallace, professor of plant physiology at that institution. The recording instrument used in the study was designed and has been described by him (*3*). It is sufficient to state here that two separate curves are made simultaneously on the same drum, but from two distinct sources of electrical energy, in this case two photoelectric cells. This is accomplished by means of two circuits, each complete in itself.

The adaptation of the instrument for use with photoelectric cells is discussed elsewhere (*4*). The primary problem in accomplishing this was to devise a method that would eliminate the error appearing in all work with these cells to date—the error resulting from differences in the angle of incidence of the sun's rays striking the sensitive elements. The best device for doing this was found to be a spherical opalescent bulb in the base of which the cell was mounted. This method completely eliminates the difficulty over the greater range of conditions, and minimizes it for the extreme angles of incidence. The underlying principle, of course, is that a sphere is in reality a point.

Considerable work has been done in the past on light measurement in forest stands with some form of instrument embodying the photoelectric cell, and concerned with so-called visible light. However, the error introduced by the inclination of the unit with respect to the sun has detracted from the value of this work. W. G. Morris (*1*), has pointed out in connection with the Weston exposure meter which uses a flat surface that "measurements to be comparable, must be made at the same angle of inclination."

It was assumed that a percentage relationship between the light intensity in the forest and in the open affords the best basis for study. Therefore one record was made from a cell in the open, and another record simultaneously from a cell at the forest station under consideration. Each cell was beneath an integrating sphere. The electrical output from the cell in the forest was, of course, less than that from the cell in the open. The planimetered areas beneath the curve for the open station and the curve for the forest station were used as the basis in calculating the transmission percentages in terms of full sunlight.

Records made on succeeding days showed

only slight variations in these percentage figures. That is, the same percentage relationships existed between the forest and the open stations on a very dark day as on a clear day, regardless of the fact that the curves for forest and open stations in the former case were but a short distance above the base. This greatly simplified the computation of the data, because no correction was necessary for varying weather conditions.

While recorded data were being obtained by the foregoing method, additional data were taken by hand at the same stations in order to secure readings which would be comparable to the summation records for the entire day as obtained on the recorder. With the recording method, one cell was permanently mounted in the top of a tall tree as the open station, and another cell was set up at the forest station being studied. In the case of hand sampling, on the other hand, only one cell was used. As this involved transporting the cell from the open station to the forest station, the tree was eliminated from use as a base, and light measurements at an open space in the woods close to the forest light stations were used as a basis for comparison. The sphere was set up in the open and connected to a millivoltmeter rather than a milliameter, in view of its greater ruggedness for field work. This involved the inclusion of a resistance coil to build up the voltage, but permitted adjustment of output to 100 on the meter when the cell was exposed to full sunlight. Subsequent values at the forest stations were thus in percent, without transposition.

On cloudy days when the light intensity varied widely over short periods it became necessary to check the base readings frequently. This was done by returning to the open space to be certain that the meter still read 100 under full light conditions. In order to eliminate this frequent checking, a multiple unit was developed. This consisted of two cells connected to the meter and wired together in such a way that they were in opposition to each other. If the electrical outputs of these cells were the same under identical light conditions, the reading on the meter would, of course, be zero. However, differences in sensitivity made it necessary to use a resistance coil to increase the output of the weaker cell, and thus bring the two into balance. With the cells balanced in this way it was then possible to take one to a forest station, and while at this station to adjust the cell in the open at 100 by cutting the forest station cell out of the circuit with a switch. Then with this done, by throwing the two cells back into opposition, it was possible to ascertain the percent transmission of the forest station in terms of the open station directly from the meter. For example, with the cell in the open set at 100, if the two cells when thrown into opposition read so on the meter, the amount of light at the forest station was 20 percent of that in the open. By this method, almost simultaneous readings were possible, and there was little chance for the total sunlight at the open station to have varied from 100 while the reading at the forest station was in progress.

Eleven stations were set up under different degrees of canopy densities with the intention of securing the greatest possible diversity. Each station was standardized with regard to the position of the sampling cell by the use of two forked sticks on an approximate north and south line. The pole to which the cell was attached was placed across these sticks. The cell was toward the south in each case, and was held firmly by means of a notch in the pole which fitted into the crotch in the southernmost stick. As has been pointed out previously, in connection with the use of the recorder, weather conditions did not effect the percent transmission figures. Likewise, when the hand reading data were examined, the only effect of an overcast day appeared to be a reduction in the variation of the individual readings, exactly as the curves on the recorder had been smoothed by overcast conditions.

Station 1, located in a mixed hardwoods thirty feet in height, and station 3 located in a group of eastern larch, were the darkest and most variable of the eleven used, and were the only two stations upon which complete information had been secured through use of the recorder. Over a period of days in April during which the trees were leafless, the transmissions at stations 1 and 3 were 58 and 33 percent respectively. It was against these recorded figures that the validity of hand sampling was checked.

A total of 27 readings was taken at each of the two stations. These included nine days on which measurements were made in the morning, at noon, and in the afternoon. Averaging all conditions, means of 65 and 35 percent were

obtained for Stations 1 and 3 respectively. The former was 7 and the latter 2 percent high when compared with the recorder figures. These figures were substantiated by repetition on two other days as shown in Table 1. The readings for the stations averaged 60 and 34 percent of full sunlight. In this case Station 1 was two percent high, and Station 3, one percent high.

In view of the fact that the recorder had shown no variation in transmission figures on successive days, an attempt was made to conduct intensive hand reading on a single day, and compare the average thus secured with the established figure which was based on a longer period. Consequently on March 30, a clear day, seven readings taken at hourly intervals from 11:14 to 4:14 resulted in an average of 58 and 33 percent for the two stations, chance probably contributing to the fact that the error was less than one percent. On April 2, a completely overcast day, four readings made at hourly intervals from 11:14 to 3:32 showed an average of 63 and 31 percent for the two stations, which is an error of plus 5 and minus 2 percent respectively. The percentages for each reading from which the above averages were taken are given in Table 2.

An interesting comparison can also be drawn between the great variation on clear days and the slight variation on overcast days.

This trend is typical of all eleven stations, and is by no means an exceptional case, as will be seen in Figure 1. It was evident from hand samplings, as the records had previously indicated, that as few as four readings made in a leafless deciduous stand may be accurate within 5 percent if taken on an overcast day when variations due to patches of full sunlight penetrating the canopy are at a minimum.

The regularity of the curves secured on the recorder indicated that by dividing each pair of daily curves into hourly portions and computing the transmission for each portion individually, a value comparable to that for the entire day might be reached in each case. These computations came within a maximum error of plus or minus 8 percent (averaging less than 2 percent) of the total daily summations, except for those hourly portions before 9 a. m. and after 4 p. m. Thus the possibility of frequent hand reading over any period between these extremes was demonstrated, as the same relationships would exist for this method as for the recorder method. The data from hand sampling were carefully scrutinized to select readings made within a period of an hour or less, preferably on completely overcast days.

On April 22, a partially overcast day, readings made at 3:05, 3:15, 3:34, and 3:39 p. m. at Station 1 showed the transmission to be 48, 56, 58, and 64 percent respectively, or an average of 56 percent, which is within 2 percent of the figure for that station taken from the record for the entire day. Readings made at Station 3 on May 15, another overcast day, with the express purpose of securing as many individual determinations as possible within an hour show the following percentages: 21, 22, 23, 23.5, 23, 22.5, 21.5, 24, 22.5, 23, 21, and 24, all at five-minute intervals from 1 p. m. to 2 p. m. The average for the hour was 22.5 percent. It should be noted that this figure is considerably below the average of 33 percent as established for this station by previous records. However, the record which was made on this day by the instrument showed a transmission summation of only 21 percent, due to the growth of leaves. Thus the error is only 1.5 percent when compared with the new standard

Table 1.—Percent of Total Sunlight at Stations 1 and 3 without Regard for Variations in Weather Conditions

Date	Station 1 Time	Station 1 Percent	Station 3 Time	Station 3 Percent
April 28	11:12	72	11:14	32
	1:14	79	1:16	43
	3:05	48	3:07	32
	3:34	58	3:36	23
	3:39	64		
April 30	2:30	47	2:32	34
	3:15	56	3:17	36
		—		—
Average		60		34

Table 2.—Percent of Total Sunlight at Stations 1 and 3 Under Different Weather Conditions

March 30 (clear day) Station 1 Time	Percent	Station 3 Time	Percent	April 2 (overcast day) Station 1 Time	Percent	Station 3 Time	Percent
9:14	64	9:17	47	11:14	63	11:17	40
10:14	69	10:17	46	1:14	63	1:17	33
11:14	66	11:17	25	2:14	65	2:17	27
1:14	64	1:17	15	3:14	62	3:34	23
2:14	43	2:17	35		—		—
3:14	28	3:17	30	Average	63		31
4:14	73	4:17	36				
	—		—				
Average	58		33				

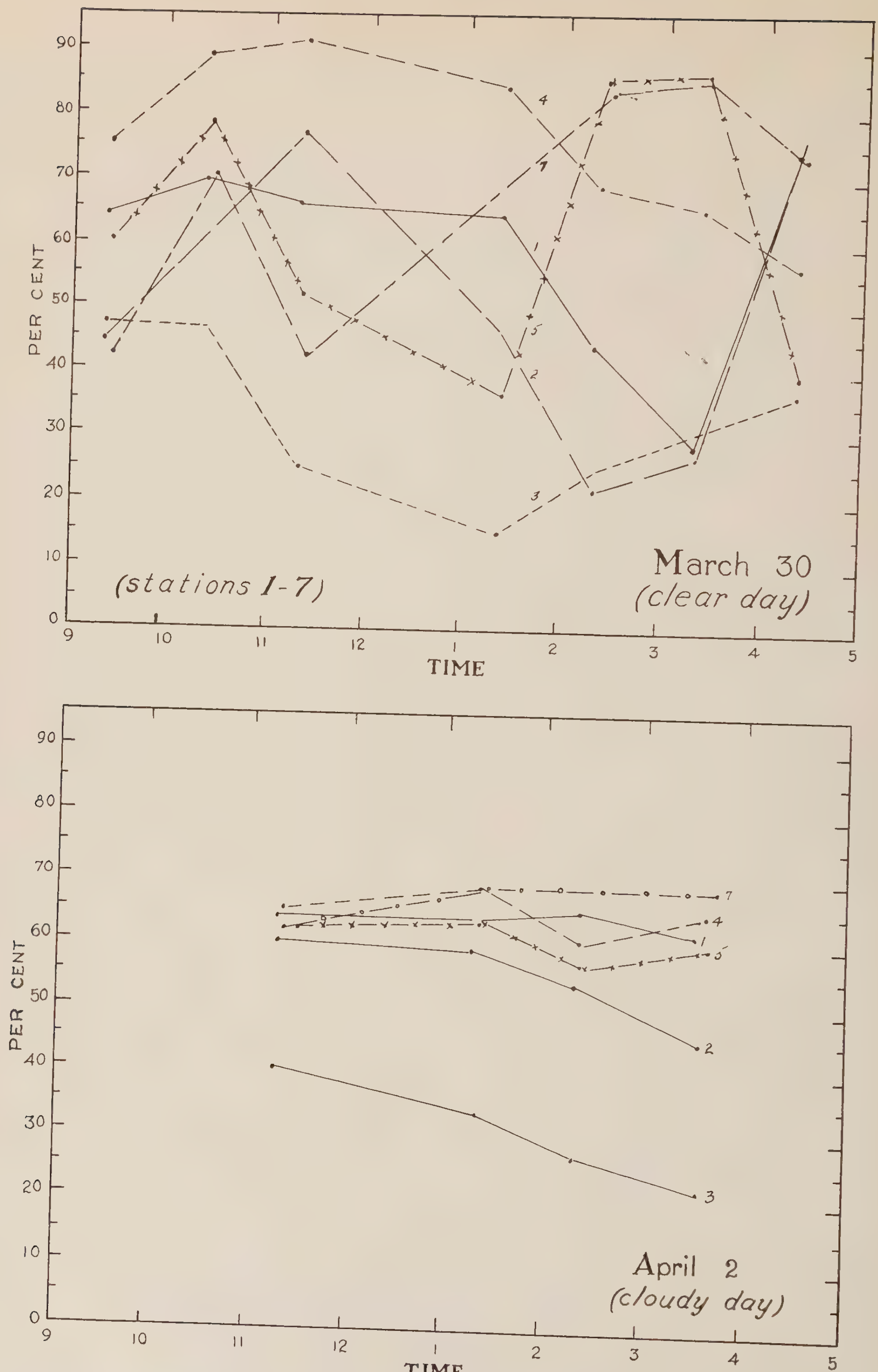

Fig. 1.—Comparative measurements under clear and cloudy conditions. *Note:* There is no graphic justification for the connection of the points. The variation between points was undoubtedly much greater than indicated, but this method seemed to be the only one which would give a comparison of the two types of weather conditions.

for the station. This decrease in light intensity due to leaf development commenced on May 10 when the leaves were still extremely small and their effect would have been assumed to be negligible. The fact that the above percentages are so much more uniform than those previously secured by hand-reading methods can only be explained by the changed condition at the station. Even though the growth of leaves had been only sufficient to decrease the percentage from 33 to 21 percent (it was later to become stable at 4 percent as will be shown subsequently), the leaves had already begun to show their effect as filters. Whereas heretofore Station 3 had been the most variable in the entire series, now this was no longer the case. In order to ascertain whether or not this had taken place at all the stations to the extent indicated by the condition at Station 3, hand readings were made on all eleven stations on June 8. The results are included in Table 3.

At Station 3, transmission percentages dropped from 33 percent without leaves to 21 percent on May 13, and then to 4 percent on June 8, at which time a stable condition had apparently been reached. These figures above

Table 3.—Percent of Full Sunlight at all Stations Under Full Canopy Conditions as Determined by Frequent Readings on an Overcast Day

Station 1		Station 2		Station 3	
Time	Percent	Time	Percent	Time	Percent
8:45	9	8:50	8.5	9:45	3.5
8:55	10	9:00	9	9:50	4
9:05	9	9:10	8.5	9:55	4
9:15	8.5	9:20	8.5	10:00	4
9:25	9.5	9:30	8.5	10:05	4
3:50	10	3:55	9		
3:55	9	4:05	8.5		
4:00	8.5	4:19	8.5		
Station 4		**Station 5**		**Station 7**	
Time	Percent	Time	Percent	Time	Percent
10:10	17	10:35	24.5	11:00	8
10:15	17.5	10:40	26	11:05	7.5
10:20	18	10:45	25	11:10	8
10:25	19	10:50	25.5	11:15	8
10:30	22	10:55	25.5	11:20	7.5
				2:27	8
				2:33	7
				2:37	7.5
Station 8		**Station 9**		**Station 10**	
Time	Percent	Time	Percent	Time	Percent
11:25	5	2:40	9.5	3:05	6
11:30	5.25	2:45	9	3:10	6
11:35	5.50	2:50	9	3:15	5.5
11:40	5.25	2:55	9	3:20	6
11:45	5.25	3:00	8.5	3:25	5.5
2:25	5.5				
2:30	6				
2:35	5.5				

were obtained both on the recorder and by hand reading, the discrepancy between the two methods being negligible. Further, it might be pointed out that there was no reproduction of any kind on the floor of this station which had a transmission percent of 4 under full canopy conditions.

Although this study was intended to determine methods for the hand sampling of light with the photoelectric cell, certain suggestive leads were obtained regarding the relative importance of light as a factor in plant growth as compared with other elements such as soil and moisture. For example, on two stations fifteen feet apart beneath a maple tree (Nos. 7 and 8), the conditions of moisture and soil were apparently identical. However, the transmission of light as measured on June 8 when the canopy had completed growth was 8 percent at Station 7, and only 5 percent at Station 8. There was a complete mat of red maple seedlings on the former and only a scattered few on the latter. Of course, with only this one case, and no determination of moisture or soil characteristics, it is impossible to say that the difference was entirely due to light. However, the possibility exists, and it may be that the minimum light necessary to support the establishment of red maple reproduction is approximately 5 percent of full sunlight—this value being based, of course, upon conditions of full canopy density during the growing season.

One of the most important facts established by this work is the uniformity of light conditions under similar stands. Stations 1 and 2 were located in a mixed hardwood stand about 30 feet in height. Although thirty feet apart, these stations show transmissions of 8.5 and 9.5 percent according to the hand readings made on June 8. This uniformity would indicate that the measurement of light in forest stands is not as complex a problem as has been supposed, and that a number of measurements within a given stand will be somewhat comparable.

A Practical Application of the Method

In order to ascertain the practicability of this method for field work, *random* measurements were made in northern white pine (*Pinus strobus*) and red pine (*P. resinosa*) plantations, and in hemlock (*Tsuga canadinsis*) stands. The object was to determine first

whether or not there was any correlation between the point at which needles die and the light intensity at that point, and second, any difference in the light intensities among the three species. It was assumed that this point would determine the degree of tolerance if the needles died when the light intensities became so low that they were of no value to the tree. The sampling was by means of a long pole on the end of which the sphere, encasing the photoelectric cell, was mounted. In some cases the last live needles were found several feet from the ground, and in others a very short distance from it. Table 4 is a summary of the individual readings made, *a* and *b* designating two distinct stands in each case.

It will be noted that the average percentage value for each species does not correspond with accepted degrees of tolerance set forth by Zon and Graves (*5*) and others, who rate hemlock as being very tolerant, northern white pine intermediate, and red pine intolerant. At first thought this would appear to indicate an error in measurement. However, in view of the uniformity in individual averages, it is more probable that the error was in the original assumption. Thus lack of light may not be the determining factor in needle cast, but rather some physiological characteristic such as the number of years the needles are normally retained in each case; or a difference in the character of the needles themselves may be of greater import.

Conclusions

The use of an integrating sphere to enclose the photoelectric cell, thus establishing in effect a sensitive *point*, eliminates the error encountered in measuring on a flat surface.

Weather conditions have no appreciable effect upon the percentage transmission values in forest stands.

The effect of an overcast sky is to distribute the light in such a way as to reduce the fluctuation of individual readings.

It is possible to secure transmission figures by hand methods which compare very closely with recorder summations for an entire day even if the readings are few in number, providing the measurements are made on an overcast day.

Readings in a leafless stand are subject to great variation due to lack of an integrating canopy.

Many plants apparently have a minimum light requirement of approximately 3-4 percent of full sunlight.

This method of using the photoelectric cell should be widely applicable for many purposes other than those cited in the foregoing investigation.

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Table 4.—Percent of Full Sunlight at the Point Where the Last Green Needles Occur

	White pine		Hemlock		Red pine	
	a	*b*	*a*	*b*	*a*	*b*
Age class (years)	20-70	25	30-50	15-35	25-30	30-35
No. of measurements	127	62	45	104	126	43
Range (percent)	2-20	2-14	1-10	1-10	1-10	1-7
Majority (percent)	4-5-6	4-5-6	4-5	2-3-4	2-3-4	2-3-4
Average (percent)	6.0	5.1	4.8	3.7	3.1	3.1

BRIEFER ARTICLES AND NOTES

The Possibilities of the Clone in Forestry[1]

The term *clone* is used to designate a group of plants which have originated by vegetative propagation from one individual seedling. The countless numbers of Eugenei poplars which have been planted as shade trees throughout the world are all members of a single clone derived from one hybrid seedling. Another well-known tree clone is the Balm of Gilead poplar which has been discussed in detail by Stout.[2] In our northern forests, "islands" of both large-tooth and trembling aspen are rather common. All the trees in such islands may be members of a single clone originating from root suckers from one original seedling tree.

A clone is not a species. Too often taxonomists have given the clone specific rank, as for example *Populus eugenei, P. serotina,* and many other poplars and willows. In many cases such clones which have been called species exist as a single sex. Certainly the minimum requirement for specific rank should be the existence of both sexes.

All the members of a clone derived by vegetative propagation from one seedling are genetically identical, with the exception of occasional sports which may give rise to some variation. These, however, are usually so slight that they will not be of importance to forestry for many years. Striking differences occur rarely and are seldom of practical value from the standpoint of the forester, although new and bizarre tree types have been of great value to horticulture.

The clone will eventually be of great importance to practical forestry because it offers definite advantages from the standpoint of uniformity of growth and development and the immediate availability of elite individuals for reforestation. It has been argued that extensive pure planting of single clones will increase the disease and insect hazard, but this can be eliminated, or at least greatly minimized, by planting a mixture of clones.

Although the possibilities for rapid vegetative propagation of conifers may appear to be somewhat limited by the fact that commercially important species, such as white pine and spruce, do not sprout, and that the number of stems available for propagation would therefore not be very large, recent work with growth-promoting substances seems to indicate that methods to induce sprouting may be developed. On the basis of the relative rate of growth of seedlings and cuttings of deciduous trees it is possible that vegetative propagation of conifers in northern nurseries may produce stock large enough for out-planting in less time than seed propagation. For example, in the vicinity of New York City poplar seedlings grow to a height of only 6 to 12 inches during the first year, whereas cuttings will grow as much as 6 to 8 feet in height in one year. Cuttings offer a further advantage because the size of such out-planting stock can be regulated by the size of the cuttings used and the time of planting.

Hardwood species, such as oak, ash, basswood, maple, and birch, are particularly suitable for vegetative propagation because most species sprout to some extent and many are prolific sprouters. Propagating stock of these species will be available in much larger quantities than in the case of conifers. For some hardwoods, such as basswood, which are difficult to propagate from seed, vegetative propagation may provide low cost planting stock.

The clone can be used to excellent advantage in forest research which is often concerned with the interrelationship between the forest stand, or plantation, and its environment. All experiments are of necessity conducted with a heterogeneous mixture of seedlings, each one potentially different from its neighbor. The use of clones would eliminate from the experimental design one absolutely unknown variable, differences in genetic constitution. The clone

[1]Received for publication May 1938.

[2]Stout, A. B. The clone in plant life. Jour. N. Y. Bot. Garden. 30: 25-37. 1929.

can also be used to excellent advantage as an indicator tree, particularly in forest planting experiments.

The clone is of special importance to the forest geneticist for early improvement of forest trees. The rapid improvement of horticultural trees has been due primarily to the possibility of multiplying excellent individuals by grafting, budding, layering, or cuttings. The possibilities for early improvement of forest trees appear to be greatest with tree species which can be propagated vegetatively by methods that are economically feasible for forest planting stock. Hybridization between forest tree species offers excellent opportunities for the creation of improved types, particularly because first-generation hybrids are often more vigorous than either of the parent species. Excellent hybrids or wildlings can be multiplied immediately and their excellent characteristics can be maintained if vegetative propagation is possible.

Because of the great importance of vegetative propagation to forest tree improvement, the work reported in the JOURNAL OF FORESTRY by Snow and by Afanasiev was undertaken in connection with the forest genetics project at the Northeastern Forest Experiment Station. This is essentially a physiological problem, but at the present time there is practically no work under way on the rooting of forest tree species of immediate concern to forest genetics research at this station. The work with dormant cuttings of aspen species and aspen and white poplar hybrids reported by Snow was carried on in a greenhouse during the late winter and early spring of 1937. The station now has a number of excellent new aspen and white poplar hybrids which cannot be satisfactorily rooted from cuttings by the usual methods. In order to test these new hybrid clones in forest plantations it will be necessary to develop a successful method for vegetative propagation.

The experiments with greenwood cuttings of gray birch, white birch, red maple, hard maple, and white poplar hybrids reported by Afanasiev were conducted in Maine during the summer of 1937. Gray birch and red maple were used because it seemed that these species might root quite easily and should therefore be included in the preliminary experiments. White birch was included because it is claimed that some individuals of this species produce superior wood, and hard maple, because some trees produce sap with a higher percentage of sugar than other apparently comparable trees in the same stand. If such outstanding individuals can be propagated as clones, they can be multiplied immediately and tested under various environmental conditions. The cuttings were planted in a sand bed—a wood frame laid on the surface of the ground and filled with 8 inches of sand. Although the first steps in experiments of this kind can best be undertaken under optimum conditions, which in this case would be greenhouse facilities, a greenhouse was not available and the work was justified on the basis that vegetative propagation in an outdoor sand bed would have direct practical application. The results obtained by Afanasiev indicate that there are excellent possibilities for the production of forest planting stock from small cuttings of some northern hardwood species.

A word of caution is necessary. This work is essentially preliminary; the cuttings were rooted, but it was not possible to carry over the rooted stock and to plant them out for further study. It may be found that rooted cuttings of some forest tree species will not grow as well as seedling trees, although this is not the case with such forest species as poplars and willows which can be easily rooted from cuttings. Further experiments at the Northeastern Forest Experiment Station will be directed toward the solution of this problem. Because of the importance of white pine in the northeastern region, this species has also been included in research now under way at the station.

ERNST J. SCHREINER,
Northeastern Forest Experiment Station.

AS OTHERS SEE US

"During the third session of the 75th Congress, several matters of concern to the association members were before Congress and Mr. Marshall has reported on various items. Undoubtedly the most important item upon which the greatest amount of time was expended was an item in the 1939 Agricultural budget of

$1,200,000 for the carrying out of the provisions of the Norris-Doxey Act. As already reported, this pernicious attempt to further encroach upon our legitimate market was defeated; not once, but many times during this single session. As Mr. Marshall has stated, the amendments offered to the regular agricultural appropriation bill and during the closing days of the session to the 2nd Deficiency Bill, would have spread this unwarranted competition into every section of the country and into every state of the Union. We are not objecting to the intent and purposes of the Norris-Doxey Act, if they are, as we believe them to be, and as Mr. Doxey himself explained them to be before the House Committee on Appropriations, the reforestation of burned-over tracts of timberland and submarginal land removed from crop production. It is not the intent of the Norris-Doxey Act to do anything but this, but the administration of the old shelterbelt project, now known as the Prairie States Forestry Project for which the Norris-Doxey Act was made a vehicle, was contrary to our interests. If the administration of the act was in accordance with the intent of the act, we would have little of which to complain. But on the other hand, when an administrative bureau uses one act, contrary to the intent of the wishes of Congress, for the perpetuation of a project which has never been approved by either branch of Congress, but on the contrary has been ordered liquidated by both branches; and when this administrative agency, in spite of this mandate, wishes to continue to grow and provide to our customers and same type of material we have been and are still attempting to merchandise, then it is high time that Congress and the nurserymen cooperated and protected not only our legitimate interests but also the prerogatives of our elected representatives. As stated on the floor of the House in the closing hours of the session, it is time to determine whether the policies of government were to be determined by Congress or by an administrative agency of government."—Extract from the report of the executive secretary, American Association of Nurserymen, to the 63rd annual convention of the association held at Detroit, Mich., July 19-21, 1938.

W.P.A. Publishes Summary and Index of Research

The results of some 2,000 research projects carried on as part of the federal work relief program are summarized briefly in a digest and index which has been published by the Works Progress Administration. This volume of 291 pages contains a concise statement of the principal conclusions of each study and an alphabetical subject index to the contents.

The reports on these projects touch upon nearly every field of natural and social science, and many of them have appeared in the form of articles in scholarly journals. However, several hundred of the reports summarized in this index are in manuscript form, and arrangements have been made with the American Documentation Institute whereby microfilm copies of the original reports will be furnished at nominal rates for the use of research specialists.

A small edition of this volume has been prepared for distribution to the larger public and university libraries, where it will be available for reference, and for government departments, industrial concerns, and research foundations. A limited supply of copies of this Index of Research Projects is still available. Requests should be addressed to the Works Progress Administration, Washington, D. C.

Fire: The Greatest Threat to Southern Forests[1]

Although outlawed by every southern state, forest fires each year burn over large areas, destroying tremendous amounts of present and potential timber. The serious and widespread losses from fire during the early months of this year serve to demonstrate this fact and to bring sharply into focus the need for more effective control of fires if southern forests are to be kept permanently productive.

To the extent possible with available funds effective protection from fire is, of course, provided in limited areas in all southern states. Usually it is a cooperative undertaking administered and partly financed by the states with the federal government assisting and the land owners or local governments assuming a substantial share of the cost.

The inadequacy of forest protection at pres-

[1]Presented at Conservation Conference, Southern Pine Association, New Orleans, La., March 23, 1938.

ent is evident from an analysis of the total privately owned forest area, by states, and the percentage under protection. Recent information furnished by the state foresters of the southeast shows that in Alabama with 21,000,000 acres of privately owned forest land needing protection, 8,400,000 acres, or 40 percent, are protected. In Florida out of 21,373,000 acres, 5,040,000 or 23 percent, are protected. Georgia, with 23,000,000 acres of forest land in private ownership protects 4,000,000 acres or only 17 percent. North Carolina with over 20,000,000 acres protects 68 percent, while South Carolina with 13,163,000 acres has 4,218,000 acres or 32 percent, under protection. Virginia protects 76 percent of its 14,000,000 acres of forest land.

No criticism of the progress made by the various state forestry departments is intended or implied by a presentation of these facts. Unquestionably the state foresters have done a splendid job with very inadequate financial support, surmounting great obstacles to accomplish what they have. But when 60 percent of Alabama's forests, 68 percent of South Carolina's, 77 percent of Florida's, and 83 percent of Georgia's are entirely unprotected from fire, it is obvious that the problem of adequate forest protection in the Southeast is by no means solved.

Lack of public funds is the only reason a much larger area does not have the benefit of organized fire protection. The recent expansion of pulp and paper manufacturing in the South has given young timber a market value and stimulated interest in timber growing. Many forest owners are eager for fire protection and are entirely willing to pay their share of the cost, but public funds for this purpose are so inadequate that several million acres that could promptly be added to the protected areas must remain exposed to fire. Greater state and federal appropriations for fire protection are an urgent necessity. They should be adequate to permit immediate cooperation with all forest owners desiring protection and be increased as rapidly as possible to give every acre of timberland the benefit of protection from fire.

Along with greater organized effort in suppressing fires must go much more care by the general public in preventing them. Statistics show that practically all fires, even in protected areas, are caused by carelessness and incendiarism. It is gratifying that the U. S. Forest Service compilation of forest fire statistics for 1936, which is the latest available data, shows railroads caused only four percent of all fires on the protected areas of the six southeastern states. This is the least of all causes except lightning which started one percent of the fires. Considering the many thousands of miles of right-of-way and numerous trains traversing forest areas it is evident that the railroads are using extreme care to avoid causing forest fires. All other fires, 95 percent of the total, resulted from some form of carelessness or incendiarism due to the old-time belief that the woods should burn every spring.

Wood consumed by industry in the manufacture of commodities is put to the best possible use, employing many people and creating substantial local and general business. Wood consumed by fire is a total loss benefiting no one. The threat to permanent southern forests lies not in the constructive use of timber for industrial or domestic purposes but in the annual fire losses on millions of burned over acres.

Some conception of the amount of timber that is wasted and goes up in smoke each year is shown by the facts obtained by the Forest Survey of the South for 1934. In the naval stores region of the Southeast alone, a forest area of 35,000,000 acres, much more pine timber is grown each year than is used, but the loss due to mortality is so great that a small net deficit in the forest budget results. In total timber the growth is shown to be 658,000,000 cubic feet of pine and the commodity drain for all purposes 313,000,000 cubic feet, or less than half the amount grown. Mortality, however, takes the startling total of 406,000,000 cubic feet, or nearly one-third more than the amount actually cut and used. In terms of board feet the story is similar. Total growth was 2,172,000,000 board feet of pine, commodity drain 1,277,000,000 board feet, with mortality amounting to 1,144,000,000 board feet, or nearly as much as the amount cut for support of forest industries and communities. The losses mentioned do not include the additional waste of future timber supplies in the form of seedlings and saplings that year after year are killed by fire, preventing the establishment of new tree crops on millions of acres nature tries to reforest.

The only constructive solution of the forest

problem in the South, therefore, is not to restrict the use of timber but to eliminate all preventable losses. While information is lacking on the exact amount of mortality due to fire, it is highly probable that two-thirds of the total is due either directly or indirectly to fire. In addition to killing trees outright, fire weakens and damages them until they are easily windthrown, or attacked by insects and decay.

Adequate protection from fire becomes, then, the first demand of common sense. When these alarming fire losses are stopped the amount of timber available each year for use will promptly increase very markedly. The forest budget of the South will then be more than balanced, and a future timber production far beyond any present market demand will be assured. But until these losses are eliminated any attempt to balance our forest budget by limiting or restricting the industrial use of timber is merely "fiddling at the spigot with the bung hole open."

A. E. Wackerman.

A Scientific Journal for Forestry

Readers of the Journal for some time have been divided on the question of the type of articles that should be published in it. Some of the readers, who are actively engaged in investigative work or are especially interested in research, would like to see more articles of a scientific character. On the whole this group is not especially interested in the seemingly large number of articles of a general nature and they are often surprised and disappointed in the quality of the papers that are supposed to be scientific. Conversely, there is a large group in the Society who feel that too much space is given in the Journal to scientific papers of limited interest to the membership of the Society. The latter group would like to see more articles having to do with the routine management of forest properties; new ideas that may be of value to them in meeting the problems that confront forest administrators day after day.

The writer believes that forestry in this country has reached a stage where it can and should have a scientific journal of forestry for the publication of the results of researches that are now not admitted to the Journal of Forestry either because of length, supposedly limited interest, or technical complexity.[1]

It seems unfortunate that many forestry articles, if published at all, must necessarily appear in the official organs of other scientific societies. These publications are often not readily available to the forest investigator. Too frequently the authors in order to get their articles into these publications must modify appreciably the technique of presentation to fit the interest of readers who are for the most part not foresters.

The writer proposes that the Society consider supporting, in addition to the present Journal, a publication of the nature of a quarterly for the presentation of results of researches that otherwise may be scattered through a half-dozen or more other journals or periodicals. Such a publication may well have different editors than those of the present Journal. The primary purpose of such a quarterly would be to publish the results of scientific studies of forestry problems.

T. S. Coile,
Duke University.

A Parable for Tax Reformers

A certain sick man came to a physician and said, "I am grievously ill and my stomach will no longer perform its appointed functions. What shall I do?"

The physician examined the sick man and after taking thought replied, "I find that you have an obstruction which should be removed. There are three different treatments to this end; I will advise which one best suits your condition. However, this treatment alone will not cure you. Your troubles come in large part from long disregard of good dietary practices. Here is a diet list. You will find it a slow and difficult process to improve your habits but your cure depends upon your perseverance."

The sick man went away sadly, murmuring, "This physician has given me no remedy," for he had hoped to receive a sugar-coated pill which he might take and wake up the next day a well man.

[1]Very few papers of the type Dr. Coile has in mind fail of publication in the Journal of Forestry because they are "not admitted." In most cases they are not submitted to the Journal.—*Managing Editor.*

The sick man is the body politic afflicted with a forest tax problem. The obstruction is the excess burden of the property tax on deferred yield forests. The three treatments are the three special forest tax plans proposed by the U. S. Forest Service. The dietary sins are the defects in organization and taxation practices of local government, the correction of which is necessary to a complete solution of the forest tax problem.

Would the physician do right to give the sick man a sugar-coated pill because the deception would make him happy for a season? Or should he seek to start him on the hard path to real improvement?

The above parable was inspired by a statement in a recent article by Mr. Luther[1] to the effect that the Forest Service (Fairchild) report[2] does not suggest a definite solution of the forest tax problem. Similar statements have come to my attention from men whose views, like those of Mr. Luther, are worthy of serious consideration. It is evident to anyone who has read this report that such criticism does not mean that its recommendations are in any way indefinite. They rather express disappointment because of its failure to offer one single, simple, and self-enforcing solution. The demand for a quick and easy cure has not been satisfied; nor can it be, because there is no such cure.

Without attempting to discuss the merits of complete property tax exemption for growing trees, the solution advocated in the above mentioned article, two comments will be offered in addition to the parable.

Mr. Luther refers to the writer as of the opinion that exemption of trees from the property tax "is entirely feasible in the State of New York and that the loss of revenue to the state would be so negligible that its tax structure would hardly be affected." This statement is accurate so far as it goes, but it would be more explicit to add the qualification that such feasibility depends on the willingness of the state to give special aid to local taxing jurisdictions which might otherwise be embarrassed by such a substantial exemption.

The argument for timber exemption based on a comparison of growing trees with annual field crops is open to question. If all or any part of the proceeds from sale of the field crop is used to build farm improvements or buy livestock, instead of being consumed, it is added to the capital invested in the farm and thus becomes taxable in succeeding years. If all or any part of the annual increment of forest trees is allowed to remain, instead of being cut and removed, it is likewise added to the capital invested in the forest. It corresponds to the proceeds of the field crop which are added to the farm capital and thereafter taxed as property. (Incidentally, such proceeds are also subject to income tax, except as covered by specific exemptions according to the status of the recipient.) Reasoning by analogy with field crops, therefore, might support property tax exemption of growing trees in an amount equal to the increment of the current year, but could hardly justify exemption of the entire forest growing stock, a capital instrument just as much as the farm improvements and livestock.

The fact that forest trees may be more largely permanent capital than crop becomes entirely clear in the extreme case of the annual sustained yield forest, the increment of which would be harvested annually, leaving the growing stock unimpaired. It is only the increment, in such a case, which is analogous to field crops, and this increment would now escape property taxation to much the same extent as such crops.

R. Clifford Hall,
U. S. Forest Service.

[1]Luther, T. F. The encouragement of private forestry in the State of New York, Jour. Forestry 36:767-771. 1938.

[2]Fairchild and Associates. Forest taxation in the United States. U. S. Dept. Agri. Misc. Pub. 218. 1935.

Preliminary Figures from Lake States Forest Survey

The inventory phase of the Forest Survey in the Lake States was completed in 1937 and preliminary statistics on forest areas and timber volumes have been released in mimeographed form. The new estimates differ in many respects from those in current use in the region. Possibly the most significant figures are those dealing with acreages of the various kinds of timber.

The Lake States is primarily a cutover region. Only 3.5 million acres of old-growth saw-timber forest remain surrounded by 52 million acres of second growth and more or less devastated land. Yet there are some en-

couraging features in the picture presented by the new survey statistics.

Practically four-fifths of the cutover lands have restocked to some type of forests. Some 3.5 million acres of second growth has reached saw-timber size. Thus, combining old growth and second growth, there are 7 million acres of saw timber in the region.

Second growth of cordwood size occurs on nearly 11 million acres, while over 26 million acres are in the restocking stage. Obviously this is not a well-balanced growing stock for sustained-yield management. Not only is there too great a preponderance of very young stands, but most of the areas are understocked. In the region as a whole, only one-fifth of the lands which have reforested naturally within the past few years are well stocked.

However, the situation is somewhat better than shown in some earlier statements. There is 40 percent more saw-timber area and 20 percent more cordwood area than estimated in 1931. There is 85 percent more land bearing pine saw timber than previously listed. Aspen, although still the largest single type in the Lake States, covers 5 million acres less than shown in the 1931 estimates.

The volume of standing saw timber is 60 percent greater than earlier estimates showed. In pulpwood, the new figures give a much larger available volume of hemlock and aspen than the former appraisal, but there is 15 percent less spruce and 47 percent less jack pine. The estimate of cedar poles is much larger than anyone has dared to claim previously. The figures show 41.5 million poles in the three states. It must be recognized, of course, that the Forest Survey has included much material which would not be considered in an ordinary commercial cruise. Scattered trees on the cutover lands have been inventoried and any tree 9 inches or more in diameter, which included a merchantable sawlog, has been tallied in the board-foot estimate.

Only 70 percent of the hardwood saw timber tallied in the survey is of good quality. Similarly, only 31 percent of the total volume of pulping species has been classified as high-grade pulpwood. And only 8 percent of the cedar poles are as long as 35 feet. This matter of quality and the relative inaccessibility of some of the remaining stands place some limitations on the availability of the volumes for commercial use.

The growth phase of the Forest Survey is not yet completed in the Lake States. Some preliminary estimates for certain Minnesota units have been released, however, and yield tables made up from the survey studies have been issued in a report dealing with the technique of the growth work. These partial results indicate that under favorable conditions, growth in these northern forests may be rapid.

From the thousands of borings taken on the survey in Minnesota, the common hardwoods —maple, oak, basswood, and elm, were found to be growing in diameter at the rate of about 1½ inches every 10 years. Pine and aspen is growing somewhat faster, 1.6 to 1.8 inches in 10 years. Growth in the coniferous swamps has averaged about .8 inch during the past decade. These rates are not as rapid as those in the South or on the Pacific Coast, but the differences are not as great as commonly supposed.

A significant feature of the growth situation is this: On the cordwood and restocking areas there are millions of 3-, 4-, and 5-inch spruce and jack pine trees and similar large numbers of 8- and 9-inch hardwoods which have no present merchantable volume. Yet in the course of the next decade these will graduate into merchantable size. By the standards of merchantability used in the survey, a 4-inch conifer has no cubic volume, a 6-inch tree has 2 cubic feet, a 7-inch tree has 4 cubic feet. Thus a 6-inch jack pine can more than double in merchantable volume in 10 years. Even black spruce will double in 12½ years. Indications are that reasonably well-stocked jack pine and aspen, 20 years of age, will grow at the rate of ¾ cord to 1 cord per acre per year during the next 20 years. Black spruce stands just below pulpwood size may add as much as ½ cord per acre for a 20-year period. It would appear, therefore, that large acreages have passed the stage where growth is most painfully slow —that is, the period from seedling up to the point where the trees begin to have merchantable volume. They are ready now to grow at a rapid rate. This is a potent argument for providing the best possible protection for the young forests already established and to avoid cutting the thrifty stands of minimum merchantable size.

In the economic units in which it has so far been possible to contrast current growth with current wood requirements, the discrepancies

Table 1.—Area of Forest Land in the Lake States by Type and Size Class

Forest cover type	All sizes	Size class of stand: Old-growth saw timber	Second-growth saw timber	Cordwood	Restocking
	Acres	Acres	Acres	Acres	Acres
White and red pine	959,200	274,600	182,400	323,000	179,200
Jack pine	2,706,000	4,400	322,100	929,800	1,449,700
Spruce-fir (upland)	3,147,300	76,000	328,700	1,186,300	1,556,300
Coniferous swamp	5,496,400	27,600	148,500	1,481,100	3,839,200
Northern hardwoods	8,214,600	2,579,100	1,190,300	1,277,600	3,167,600
Oak	3,519,000	303,800	559,300	1,232,300	1,423,600
Bottomland hardwoods	1,973,100	222,300	292,300	732,700	725,800
Aspen-birch	16,671,800	49,300	506,800	3,251,500	12,864,200
Scrub forest	1,702,900	49,000	7,000	422,600	1,224,300
All cover type	44,390,300	3,586,100	3,537,400	10,836,900	26,429,900
Deforested	11,244,100				
Total	55,634,400				

Table 2.—Volume of Saw Timber and Pulpwood in the Lake States
Saw Timber—By International ¼-inch Rule

Species	Regional total	Minnesota	Wisconsin	Michigan
	M. bd. ft.	M. bd. ft.	M. bd. ft.	M. bd. ft.
Softwoods				
Hemlock	9,222,000	----------	2,672,000	6,550,000
White pine	3,753,200	1,598,200	1,145,000	1,010,000
Red pine	1,478,380	998,380	293,000	187,000
Jack pine	2,677,790	2,262,790	246,000	169,000
Spruce	2,362,730	1,240,730	138,000	984,000
Balsam fir	1,089,310	350,310	133,000	606,000
Tamarack	297,340	137,340	82,000	78,000
All softwoods	20,880,750	6,587,750	4,709,000	9,584,000
Hardwoods				
Sugar maple	10,538,120	306,120	2,809,000	7,423,000
Yellow birch	5,252,230	93,230	1,388,000	3,771,000
Basswood	2,039,200	451,200	828,000	760,000
Elm	3,178,690	701,690	1,229,000	1,248,000
Beech	1,496,000	----------	170,000	1,326,000
Oak	5,297,790	761,790	3,325,000	1,211,000
Aspen	4,125,700	2,366,700	804,000	955,000
Paper birch	1,288,340	783,340	160,000	345,000
Miscellaneous	3,518,920	402,920	1,190,000	1,926,000
All hardwoods	36,734,990	5,866,990	11,903,000	18,965,000
All species	57,615,740	12,454,740	16,612,000	28,549,000
TOTAL VOLUME OF PULPING SPECIES—CORDS				
Hemlock	33,774,000		10,358,000	23,416,000
Spruce	16,628,000	10,292,000	1,045,000	5,291,000
Balsam fir	13,369,000	5,134,000	2,108,000	6,127,000
Jack pine	17,960,000	13,565,000	2,406,000	1,989,000
Tamarack	3,079,000	1,639,000	648,000	792,000
Aspen	43,776,000	22,081,000	9,647,000	12,048,000
Total	128,586,000	52,711,000	26,212,000	49,663,000

have not been large. There is a tendency, however, for cutting to proceed on the more accessible areas and with the choicer species, while growth is widely scattered and confined more to the small trees.

The full significance of the survey will not become apparent until growth and depletion statistics are available for the entire region. The figures now at hand, however, make it clear that the Lake States region still has a forest resource of great size and considerable value. With proper management, it has possibilities of recovery and in the not too distant future.

R. N. Cunningham,
Lake States Forest Experiment Station.

Comments on Henze's Article "A Device for Measuring Sample Plot Radius"

In the June 1938 issue of the Journal Karl D. Henze describes a new combination of telescope and stadia rod for use in measuring sample plot radii in timber estimating. A $98 telescope was fitted with stadia hairs at an interval of 1 to 66 and special rods were prepared for each plot size. The author explains the use of this instrument in checking whether "line trees" were to be tallied as "in" or whether they were "out" or beyond the plot radius.

The accuracy of this method of measuring short distances is questioned, as is the practicality of the method. Henze states, "Experience with the instrument has been somewhat limited, but in a number of cases the telescope checked against the tape enabled the observer to call trees "out" or "in" correctly within less than a *foot* and in general within less than *half a foot.*" Is this a typographical error, or does the author believe that one foot in a measurement of, say, 58.9 feet (radius for ¼-acre plot) is sufficiently accurate? If an error of one foot were added to the plot radius it would result in taking in 2.7 percent more area than ¼ acre.

In the Southern Forest Survey the party chief, standing at the plot center, could almost invariably determine whether a tree near the edge of the plot was "in" or "out." With only a limited amount of training he could call such trees closer than one foot. Only occasional borderline cases required checking with a tape. The Survey used 60-foot tapes rigged up with a bent horseshoe nail which could be pushed into the bark; the tape was reeled out till the plot center was reached, when the distance was read. This reading plus one-half the d.b.h. of the tree in question determined its plot status. Trees were often thrown out on the basis of one-half inch—not one-half foot. The use of a tape is much cheaper, and it does not require frequent adjustment.

The use of this high-priced instrument to do a simple, easy job is certainly open to question. It is just one more gadget the field estimator would have to carry.

Other objections to the use of telescope and stadia in sample plot work are:

1. The use of the telescope is impractical in dense undergrowth.
2. Rough treatment would easily put the instrument out of adjustment, resulting in cumulative errors.
3. It is doubtful whether the time saved, if any, would allow the instrument to pay for itself under present wages paid estimators.

G. H. Lentz,
U. S. Forest Service.

Erratum

In the article entitled "Forest Classification: Classification of Forest Sites with Special Reference to Ground Vegetation," Journal of Forestry 36:1062-1066 (October 1938) the first word in the last line on page 1065 should read "competition."

REVIEWS

Indicators of Southwestern Range Conditions. By M. W. Talbot. *U. S. Dept. Agric. Farmers' Bull. 1782. 35 pp., 36 figs. Govt. Printing Office, Washington. 1937. 10 cents.*

Land use, past and present, is indicated in innumerable ways, as stated in the bulletin. On some areas, and under certain ecological conditions, land use indications are readily interpreted. More generally they are "framed in code," the translation of which is possible only through years of contact and close observation with practical land-use problems, or through intimate knowledge of plant nutrition, trends in plant succession, and the matching up of areas whose degradation, or whose forward march of the cover, has long been under observation. Thus the author states, "Until the pattern is more nearly complete, decipherment of the indicators will continue to be difficult. The problem is complicated, directly or indirectly, by natural land features. Grazing grounds are found at elevations of from 1,000 to 13,000 feet. Relief varies from nearly flat plains and mesas to steep, rocky mountains. Character of ground surface, soil, type of vegetation, aspect, degree of slope, and climate—all affect forage production and use. There is tremendous variation in seasonal distribution of precipitation as well as in the annual amount, which seems to rise and fall in irregular cycles of years; while periodic droughts make difficult the evaluation of other factors that tend to cause decline in forage production."

Although the recognition of land-use indicators is about as old as agriculture itself, understanding of the "signs on the ground" will long engage the attention of leading ecologists the world over. Where improvement or decline in the cover has reached an advanced stage, the key guides often become so masked as to lose much of their value. Further study should make possible more reliable detection of small departures from the norm in the production of economic vegetation, thus serving to indicate essential changes in the management. Abusive grazing is perhaps the primary influence which has adversely affected vegetation, watershed, and soil conservation, but many other factors, notably climate, combine to hasten the end result.

In examining the range, therefore, various points must be taken into consideration. Range deterioration may be accelerated by drought, the construction of roads and trails, cultivation, rodents, fire, and logging. Knowledge of the history of the range is important, for it will often show what the range cover was originally. Topography and soil are important, for obviously grazing must be more conservative on steep slopes or on loose soil. Then, too, one should know whether, during the period of deterioration, the seasons were above or below average in growth potential.

Change in cover from desirable, palatable vegetation to undesirable species invariably implies lower carrying capacity. "An example would be a range on which 'six-weeks grasses,' weeds, or inferior shrubs are actually encroaching upon areas originally dominated by blue grama. The difficulty is to recognize actual encroachment at the present time, as distinct from existing remnants of past encroachment which may be found on ranges that are now improving."

Erosion is regarded as a less reliable grazing indicator than vegetation, yet distinct increase of recent gullies certainly indicates a declining range. Also failure of vegetation to reclaim small gullies is a hint that recuperation has not begun.

Experimental data are not yet sufficient to show a close tie between overgrazing and abundance of noxious weeds. Likewise poor condition of the stock, often associated with declining range, and the extent of browsing of timber reproduction, have distinct limitations as indicators of overgrazing.

It is not the aim of the paper, being a farmers' bulletin, to offer much new information,

or to propose a new technique in the recognition and use of range indicators. It does offer a clear analysis of the information at hand in language readily understood by laymen.

It is unfortunate that the many well selected halftones, which might have served so effectively in clarifying various points, were printed on paper so poor as to make many of them almost useless. In this respect the publication tends to give the impression that the Government Printing Office must have been preparing for a tail-spin into receivership.

ARTHUR W. SAMPSON,
University of California.

Stumpage Prices of Privately Owned Timber in the United States. By Henry B. Steer. *U. S. Dept. Agric. Tech. Bull. 626. 163 pp. 78 fig. Govt. Printing Office, Washington. 1938. Price 20 cents.*

This bulletin should be read in conjunction with Steer's article on statistical research in the September JOURNAL, for it exemplifies the principles which he there sets forth.

The bulletin, after some preliminary remarks on the extent and importance of forests in the United States, the sources of stumpage data, and the method of compiling, launches into a very readable discussion of the nature and difficulties of the problem of stumpage prices. It is addressed to every forester who has contended with the vexatious task of determining stumpage values.

The analysis of national stumpage prices shows that the peak of actual softwood stumpage prices was in 1927 and the peak of hardwood prices one year later. When the actual prices are adjusted to allow for changes in the purchasing power of the dollar, the peaks fall in 1914 and 1928 respectively. From these peaks, the present (1934) prices present a marked recession to \$2.43 per M. ft. b.m. (adjusted) for softwoods and \$4.63 for hardwoods.

There follow detailed regional stumpage prices for the period 1900-1934, for the ten regions into which the country is divided. These will repay careful study.

Next comes an analysis of stumpage prices of individual species, which the reviewer found of extraordinary interest. The tables and charts reveal that, for the chief softwoods, the adjusted peak stumpage prices and the 1934 prices were as follows:

Species	Adjusted stumpage price per M.b.m. Peak Value	Peak Year	1934 value
Northern white pine (N. E.)	\$8.21	1921	\$4.90
Eastern spruce	7.44	1932	3.77
Southern pines	5.15	1923	3.50
Douglas fir[1] (Western Oregon)	1.95	1922	1.50
Ponderosa pine (Inland Empire)	3.19	1924	2.27
Sugar pine (California)	4.34	1930	3.42

[1]Includes some western hemlock.

The final section of this meaty bulletin is a comparative study of stumpage, log, and lumber prices. The author admits that available records of log prices are not as adequate as are stumpage price records. Nevertheless, the record is surprisingly complete.

In summarizing, the author shows that the trends of stumpage, log, and lumber prices are distinctly similar to that of the all-commodity index. However, prices received by farmers for farm products have been less stable than stumpage and log prices. As the author says: "These comparisons clearly indicate the desirability of supplementing farm incomes, particularly in the eastern United States, through the production of forest products as a regular part of farm economy. Such a program would, of course, require the keeping of farm woodlands in a productive condition."

Mr. Steer, in writing this bulletin, has rendered a real service to the forestry profession and to the timber owner and operator. He has shown the ups and downs of stumpage, log, and lumber prices and the picture is not a particularly cheerful one. Definitely past is the boom era when huge speculative profits could be made on stumpage prices. However, as the bulletin shows, *ceteris paribus*, the producer of standing timber will obtain at least as stable a price for his product as will producers of most other commodities.

A. B. RECKNAGEL,
Cornell University.

This publication sums up the studies of stumpage prices, made by the Forest Service, for the period 1900-1934. The subsequent period of 3½ years may be about the average time required for editing, approving, and publishing statistical and other government bulle-

tins. In this case, however, the delay has not in any way diminished the value of the contents. The purpose, which was to bring out long-time trends of stumpage prices, has been carried out as well as the complicated character of the subject permitted.

The record of stumpage prices is based on more than 50,000 transactions and nearly 500 billion board feet of standing timber. The conclusion is that the long-time trend of stumpage prices since 1900 has been distinctly upwards in the country as a whole, when adjusted to the purchasing power of the dollar. There have been recessions in the price of standing timber during periods of depression. Hardwood stumpage has appreciated faster than softwood, owing to more limited supply. Interregional competition, reduction in building activities, and the use of substitutes caused the decline in softwood stumpage from 1920 to 1932.

Stumpage prices have been more stable than those for logs, though following similar trends. Greater accessibility has given greater stumpage values to small second-growth timber than to virgin stumpage in remote regions. It is concluded that on good soils timber growing should be most attractive in regions of large consumption of lumber and other wood products near centers of population. Millions of acres are available, thus located.

Throughout this report, the evidence is emphasized that the price of stumpage is actually a residual or margin, captured by the owner from the economic margin left for division between purchaser and seller, after deducting costs of logging and milling from lumber prices, or logging costs from log prices. It is shown how during the period previous to 1929 western lumbermen and speculators in stumpage still clung to the economically false basis, for stumpage value, of charging past costs and carrying charges, including interest, as the basis of sale value, resulting in predictions for Douglas fir stumpage by 1940 of $16 to $18.

Attention is also called to the difficulty of securing adequate comparisons of stumpage prices for timber of similar quality and accessibility. Such factors as the increasing cost of logging and the lowering of quality limits on the marginal tree obscure the appearance of steadily increasing margins for forestry practice on better located lands.

This publication will repay careful reading. It is an outstanding example of both the difficulties and the possibilities of drawing beneficial conclusions from long-continued, extensive studies of statistical data. In its discussion of the tendencies affecting stumpage values it reinforces sound principles of appraisals and lends aid to the forces seeking to improve the economic opportunities for producers of timber by the use of intelligent methods of appraisal of the value of stumpage.

H. H. CHAPMAN,
Yale School of Forestry.

The Distribution of Important Forest Trees of the United States. By E. N. Munns. *U. S. Dept. Agric. Misc. Pub. 287. 176 pp. 170 maps. Govt. Printing Office, Washington. 1938. 35 cents.*

Foresters, dendrologists, taxonomists, and others interested in tree ranges, also will be interested in this pictorial presentation of the geographical distribution of American trees. Utilizing the data on tree distribution which the Forest Service has been accumulating since the turn of the century, the author, in an effort to present with finer precision and greater detail than is ordinarily possible by mere tabulations, has mapped the range of each of 170 trees and large shrubs indigenous to the United States. Each map measures 6¼ by 9¼ inches and depicts only that portion of North America in which the species under consideration occurs. All physiographic features have been eliminated so that the distribution of a species, which is shown for the most part in solid black, stands out in bold relief.

In plotting these maps the author was careful to include the location of disjunct areas and outposts of a species when such were known to exist. No endeavor was made to set off the commercial limits of any species, however, because as Munns himself indicates, "changing demands, practices, and standards in utilization would make such information out of date in a relatively short time." The author also clearly points out that there was no attempt to show either the density or continuity of occurrence of any species. Hence, with this in mind, it appears a bit unfortunate to this reviewer that the style of mapping was not preserved with respect to several eastern species

such as black willow, southern cottonwood, boxelder, and others where it is obvious that an effort was made to show their proximity to water courses. In fact the map of hackberry distribution gives entirely the wrong impression since this species is found on dry, rocky ridges in some parts of its range.

It is instantly recognized that in a publication of this sort there must of necessity be some arbitrary limit in regard to the number of species included. Thus there seems to be little justification for the inclusion of such species as *Cercis occidentalis, Kalmia latifolia, Ptelea trifoliata, Cercocarpus ledifolius, Hamamelis virginiana, Acer pennsylvanicum, Prunus virginiana*, and a few others, which are scarcely more than shrubs throughout most of their range, when they apparently are included at the expense of several important tree species such as *Ulmus fulva, Ulmus racemosa, Hicoria ovalis, Magnolia grandiflora, Quercus nuttallii, Quercus lyrata, Tilia heterophylla* and *Cupressus arizonica*, all of which are conspicuous by their absence.

The nomenclature employed in this publication follows the *Check List* except in 17 instances where minor corrections have been made. These the author lists.

In conclusion the author asserts that "the Forest Service will welcome data indicating the need for changes on these present maps." It is with this in mind that the following additions and corrections are suggested.

Map 1. Northern white pine. It is very doubtful if this species occurs naturally within the State of Alabama as indicated. Harper[1] fails to mention it and in recent correspondence with this reviewer he states that, "The white pine does not occur naturally in Alabama or within 50 miles of its borders as far as I know."

Map 5. Whitebark pine. This species occurs in the high watersheds of the Olympic Mountains in western Washington. The writer himself has observed it at the headwaters of the Duckabush and Dosewallis Rivers and has herbarium material collected from that of the Dungeness.

Map 12. Red pine. A disjunct of this species is reported in the Millspaugh *Check List of West Virginia Flora* (1913) in Preston County.

Map 21. Virginia pine. This species is exceedingly rare if not altogether absent in the Carolinas east of the Piedmont.

Map 35. Eastern hemlock. A disjunct of this species occurs in southeastern Wake County, N. C. Herbarium material is on file in the Duke University herbarium.

Map 80. Sweet birch. This species does not occur in the coastal forests of New Jersey as indicated.

Map 84. Paper birch. A disjunct of this species occurs on North Fork Mountain, Pendleton County, W. Va.[2]

Maps 92 and 167. Red oak and red ash. These two species occur over wide areas in central and eastern sections of the Piedmont region.

Map 93. Pin oak. Pin oak is found in the vicinity of Niagara Falls, but does not occur elsewhere through central New York as indicated.

Map 155. Cascara. As a result of misidentifications this species was reported as occurring in New Mexico, Arizona, and southern California. A number of taxonomists now agree that the southern form is *Rhamnus betulaefolia* and that cascara is restricted to southern British Columbia, western Montana, northern Idaho, Washington, Oregon, and northern California.

E. S. Harrar,
Duke University.

Timber Drying and the Behaviour of Seasoned Timber in Use. By R. G. Bateson. *138 pp., 28 fig. Crosby Lockwood & Son, Ltd., London. 1938.*

The author has presented a clear and readable treatise on the fundamentals of seasoning. The work will be most valuable to those who desire only a general knowledge of seasoning, with particular reference to English methods. In all probability it will not be found satisfactory as a text book because many of the factors influencing the whole seasoning procedure have not been thoroughly covered.

Air seasoning and kiln-drying of domestic and imported species are discussed. Drying schedules are included. The designs of several types of kilns, together with an explanation of

[1]Harper, R. M. Economic botany of Alabama. Geol. Surv. Alabama, Monograph 9. 1928.
[2]Proc. W. Va. Acad. Sci. 9:29-31, 1935.

temperature controls and methods of kiln operation, are included. To those familiar with modern kilns in the United States, a comparison with the English kiln design will be interesting because of the similarity. Many of the refinements and late developments in kiln designs and operating practices are not discussed.

One chapter concerns the behaviour of seasoned timber in use, briefly discussing such items as hygroscopicity, equilibrium moisture content, and suitable moisture content for specific uses. Although nothing new is offered, the specific application of these items to conditions in the British Isles is enlightening.

In conclusion the author states ". . . the standard of timber drying in this country is scandalously low. . . ." Also "The objective of this book has been to assist in eliminating errors in drying practice which occur irrespective of the finer characteristics of timber."

Glenn Voorhies,
Oregon State College.

The Art and Science of Protecting Forest Lands from Fire. By George H. Schroeder. *184 pp. Illus. (Lithographed.) Oregon State College Cooperative Assoc., Corvallis, Oregon. 1938. $3.50.*

"It has been said that the practice of forestry in the United States consists almost entirely of protecting the forest lands from fire. To believe implicitly in such a philosophy would be to miss sight of the great possibilities in the other branches of forestry. Certain it is, however, that the field of protection has not received its full quota of regard in the teaching of forestry at our institutions. With that in mind this work has been completed in an effort to allow the embryo forester to see something more of the vast field of protection. As it now stands this manual represents but a beginning which through the years may grow to something commensurate with the importance of the subject of which it treats."

Thus does the preface of Schroeder's classroom text sum up his objectives.

The author presents a wealth of up-to-date material drawn from current circulars, manuals, instructions, and his own first-hand familiarity with fire control in Washington and Oregon. There are many illustrations, most of them new. They have been well chosen and add a distinct flavor of realism and action to the text. The subject matter is presented in four parts: I. History, importance, and causes of forest fires; II. Fire prevention; III. Presuppression; and IV. Fire suppression. The appendix contains a glossary of forest fire terms, a summary of Washington, Oregon, and California fire laws, and a list of selected references.

Although the text contains some inexact statements that will jar on the technician's ears and the style is not always as crisp and impersonal as it might be, this publication is a worthwhile exposition of a field of forestry in which the number of textbooks is extremely limited.

Donald N. Matthews,
U. S. Forest Service.

Western Red Cedar: The Ideal Pole. By J. P. Wentling. *69 pp. Illus. Western Red and Northern White Cedar Association, Minneapolis, Minn. 1938.*

Lumber and forest products trade literature of recent years compares favorably with that published by other industries. It is highly informative, authoritative, and well written and illustrated. Wentling's book is well within this category. He has taken the lowly telephone pole, one of the simplest products of the forest, and pointed out its real importance in our daily life as well as its importance to the industry producing it. Wentling is probably the best informed man on poles; he also has imagination. The combination of technical information and imagination actually gives dramatic interest to the tall, slender, cross-arm-laden roadside objects that none too infrequently offend our eyes.

The information offered includes a description of the forest; the tree; methods of cutting and transportation; storage; methods for testing strength; specifications for dimensions and for preservative treatment; use in telegraph, telephone, power, and other pole lines. The nomenclature and durability of the wood are adequately treated, although some criticism may be made of the author's classification of western red cedar as a "true cedar."

The book is as complete a manual on one forest product as has been written and is a credit to the author and the association for which he is research engineer.

EMANUEL FRITZ,
University of California.

Knots in Second-growth Pine and the Desirability of Pruning. By Benson H. Paul. *U. S. Dept. Agric. Pub. 307. 35 pp. Illus. Govt. Printing Office, Washington, 1938.*

This publication clearly describes how knots are formed and the role they play in affecting the production of clear lumber in second-growth pine. Six species of pine—northern white (*Pinus strobus*), red (*P. resinosa*), shortleaf (*P. echinata*), longleaf (*P. palustris*), slash (*P. caribaea*), and loblolly (*P. taeda*)—are discussed from the standpoint of their ability to prune naturally in understocked second-growth stands. It is shown that white pine prunes more slowly than any of the other pines studied. The text is exceptionally well illustrated with charts and photographs.

Although the occurrence of knots, their formation, the average number in the trunks of trees of the six species, and the size of knots as related to stand density and breast height diameter are treated in detail, the treatment of the second half of the subject—desirability of pruning—is somewhat sketchy. It is summed up briefly in the following statements: "Lumber cut from the first pruned section of northern white pine trees pruned 40 years before felling had 90 percent of the lumber entirely clear of knots. The spread in price between clear and common grades varies considerably from time to time, depending upon supply and demand. Roughly the lower clear grade of softwoods has a market value from 30 to 60 percent greater than that of the upper common grade. Undoubtedly, for a long time in the future, if not indefinitely, the demand for clear grades of lumber will continue. Whether it will pay to prune will depend upon the differences in price in lumber grades and the cost of pruning, which will vary widely under different conditions."

This statement sums up the whole question of the desirability of pruning from a dollars-and-cents standpoint. To prune or not prune, that is the question. The practical timberland owner would like to know:

How many trees per acre to prune?
What type of tree to prune?
How high up the trunk to prune?
What it will cost per tree or per acre under specific conditions?
And above all, will it pay?

These questions need to be answered before foresters can make definite recommendations regarding artificial pruning for specific stands of second-growth pine.

The author recognizes that he has not covered these points and in the introduction says, "The present study constitutes only one phase of the general problem of pruning." The Forest Products Laboratory is carrying on further investigations to find answers to the many questions on pruning which are bound to arise as our second-growth stands are handled more intensively.

G. H. LENTZ,
U. S. Forest Service.

Kolonialforstliche Mitteilungen (Reports on Colonial Forestry). *Band 1, Heft 1. 282 pp. Illus. Verlag J. Neumann, Neudamm-Berlin. May 1938.*

This is a new periodical, to be published at irregular intervals, under the auspices of the Institute for Foreign and Colonial Forestry at Tharandt. It is edited by Prof. Heske. It deals mainly with tropical forestry, and particularly with forest problems of the former German colonies. The first issue is made up largely of papers presented at the inauguration of a course in colonial forestry at Tharandt, in December 1937.

Interesting from a scientific standpoint is Grünwoldt's paper on methods of studying yields of tropical forests, where growth rings are lacking or are not dependable evidence of age. His method, which is not developed in detail, is based on the hypothesis that equivalent forest sites will produce in a given time approximately equal weights of organic substance, regardless of tree species, and that this productive capacity tends to increase regularly from high latitudes toward the equator. By correcting for differences in latitude it may be

possible to estimate the weight of wood that will be produced on a given site, on the basis of yields in northern latitudes. Yield in weight can then be converted to terms of volume, by making due allowance for the specific gravity of the tropical species in question.

The new journal supplements *Zeitschrift für Weltforstwirtschaft* (*Review of World Forestry*), published by the same Institute under Prof. Heske's editorship. The *Zeitschrift* has published a number of original papers on forestry in various parts of the world, including the United States and Canada. It gives considerable space to brief abstracts of current publications from all over the world on forest policy, forest management, and forest industries and technology. Papers are in German, French, or English, usually with an English summary when the text is in one of the other languages.

W. N. SPARHAWK.

The Relation between Mycorrhizae and the Growth and Nutrient Absorption of Coniferous Seedlings in Nursery Beds. By H. L. Mitchell, R. F. Finn, and R. O. Rosendahl. *Black Rock Forest Papers* 1(10):58-73. *2 pl., 2 fig. Cornwall-on-the-Hudson, New York. 1937.*

On an artificial soil low in phosphorus and nitrogen, good growth of second-year seedlings occurred in patches which gradually extended in area, but outside of these patches pine made poor growth and spruce ultimately died. On the good seedlings about two-thirds of the short roots were ectotrophic mycorrhizae, while on the stunted seedlings only 1 to 10 percent were so classifiable; most of the nonmycorrhizal short roots were pseudo-mycorrhizae (in the sense of Melin (1917)), which are fungus-infected short roots definitely differing in structure from mycorrhizae. The root forms of pines were described and illustrated by Hatch and Doak (Jour. Arnold Arboretum 14: 85-99. 1933). The poor seedlings showed not only the yellowish color that might be due to nitrogen hunger, but the purplish discolorations that frequently accompany phosphate starvation in conifers; analyses in August showed their nitrogen and potassium content to be three-fourths and phosphorus only three-eights as much as in the good seedlings. Analysis of soil from around mycorrhizal roots for readily available N, P, and K showed it not significantly different from that around pseudo-mycorrhizal roots. In the same soil to which fertilizers had been added, no mycorrhizae developed despite a light inoculation with soil that had contained mycorrhizae, but the seedlings nevertheless were 65 percent heavier than the mycorrhizal seedlings of the unfertilized soil and still richer in the three minerals. It is concluded that the evidence confirms the hypothesis of Stahl as extended by Hatch, that mycorrhizae are unnecessary and unable to develop on highly fertile soil; that on the other hand they are absolutely necessary on less fertile soil, and that their helpful function probably lies in directly supplying minerals to the root rather than in merely increasing the availability of the minerals in the neighboring soil as believed by Burges. Partly on the basis of the extremely poor growth and low nutrient content which the authors found in abundantly mycorrhizal pine on a very poor nursery sand, they recognize that the beneficial effect may be prevented by limiting factors. They very properly point out that it is not safe to draw inferences on nutrient absorption on the basis of growth comparisons unless supported by chemical analyses. The conclusions are in accordance with the evidence available, but perhaps more positive and given a more general application than can be entirely justified. The paper holds high rank among contributions to our understanding of the function of mycorrhizae.

CARL HARTLEY,
K. D. DOAK.

The Properties of Australian Timbers. Part 3. Pinus radiata D. Don (Pinus insignis Doug.), Insignis, Monterey, or Remarkable Pine. *Div. Forest Prod. Tech. Paper 28. 31 pp. Australian Council Sci. and Indust. Research, Melbourne. 1938.*

In Australia about 150,000 acres and in New Zealand 500,000 acres, or 70 percent of all conifer plantations in each case, have been stocked with Monterey pine. This species also has been introduced into South Africa. Its superiority over competing species lies principally in its rapid growth, the greater distance

between knots (two factors which probably are related), and its lower shrinkage but about the same strength as Baltic pine (*Pinus silvestris*). It is easily worked, not naturally durable, but takes preservative treatment well on account of its large percentage of sapwood. It has a tendency to warp which is ascribed to the presence of spiral grain in the crown and near the center in the trunk below the crown.

The use of Monterey pine for kraft pulp is well established but its use for sulphite pulp depends on technological developments in overcoming pitch troubles. Pruning of young stands so as to produce clear lumber is recommended.

It is not known whether the species was originally introduced into Australia by design or by chance. It first received attention as an ornamental tree about 1860, and was used for forest plantations from 1880 onwards.

ARTHUR KOEHLER,
U. S. Forest Products Laboratory.

The Physical Basis of Mycotrophy in Pinus. By A. B. Hatch. *Black Rock Forest Bull. 6 x+168 pp. Illus. Cornwall-on-the Hudson, N. Y. 1937. $3.50.*

In the most comprehensive approach to the mycorrhizae problem since Melin's 1925 contribution, Dr. Hatch has added much fundamentally to the intricate but still very incomplete knowledge of root function in forest trees generally. He makes it clear that his main fundamental deduction is based on the inorganic nutrition hypothesis of Stahl (1900). In addition, however, he presents evidence and ideas from other angles that warrant attention by students of nutrition of woody plants.

The bulletin gives the most useful review of literature now available on the forest mycorrhizae. Important statements and illustrations from relatively inaccessible sources are reproduced in full and the bibliography includes 206 titles. Despite the mass of observational material, this literature records little controlled experimentation.

The view that mycorrhizae are harmful, early held by Hartig and others, the author considers to have been based on two errors. They wrongly supposed that the shortness of the mycorrhizal short root was due to its fungus; and they attached causal significance to associations between mycorrhizal abundance and poor growth, when both phenomena were really due to soil poverty instead of one causing the other. The author adopts and develops Stahl's hypothesis, that mycorrhizae are beneficial through improving the ability of the pines to absorb minerals. This acceptance is based on the following premises:

(1) Mycorrhizal short roots have greater exposed surface, and cortex and endodermis continue longer without suberization than the non-mycorrhizal.

(2) In soils new for pine, on which there has frequently been complete failure to grow after the first months, satisfactory growth has followed the introduction of soil or seedlings from old pine areas.

(3) In pure-culture inoculation experiments by Hatch on an American prairie soil (Jour. Forestry 34:22-29) and Young on an Australian soil, mycorrhizal fungi made the difference between success and failure of pine.

(4) Inverse correlations have been found between inorganic nutrient supply and mycorrhizal development.

(5) In Hatch's pure-culture experiment, and in accidental infection of artificial soil reported by Mitchell et al (reviewed in this issue), the mineral content of the mycorrhizal seedlings was much higher than of the non-mycorrhizal.

Hatch obtained experimental indications that pine can obtain nitrogen from peptone or nucleic acid equally well with or without mycorrhizal fungi. While he considers mycorrhizae an aid in the absorption of inorganic nitrogen along with other nutrients, he regards as conclusively disproven the theory that mycotrophy is a special adaptation for the acquiring of nitrogen. Results obtained in liquid or sand cultures that might be considered inconsistent with the mineral absorption theory of mycorrhizal benefit are explained on the ground that the minerals in such cases, being already in solution, are so readily available that absorption is not a limiting factor; that it is when the minerals must be obtained from the base exchange complex that mycorrhizal fungi are helpful.

In Hatch's discussion of the mycorrhizae he refers to other short roots merely as non-mycorrhizal. Many readers may infer that

these are uninfested. In fact under most conditions nonmycorrhizal short roots are regularly pseudo-mycorrhizae infected with fungi and lacking root hairs, as Hatch in an earlier publication helped to point out. These pseudo-mycorrhizae are pictured at the top of his frontispiece but without identification. The probable absorptive inefficiency of the pseudo-mycorrhizae is readily apparent, and an understanding that they are the ordinary alternatives of mycorrhizae makes it easier to accept Stahl's hypothesis.

The conclusions as to the significance of mycorrhizae in forestry seem more sweeping than the evidence justifies. The experience with mycorrhizal deficiencies in countries in which pines had been sown outside their natural range is used as a basis for general advice to attend to inoculation, not only in afforestation but in much reforestation. The frequent failures of direct seeding operations and of the bulk of the seedings in the prairie region under the Timber Culture Act of 1873 are assumed to have been due primarily to lack of mycorrhizae, an interesting speculation but scarcely a subject for definite conclusion on the basis of the evidence now available. In American nurseries examined stock has been found mycorrhizal in some degree in all but a few; growth generally has been satisfactory. The majority of plantation failures have appeared to be due to factors other than absence of mycorrhizae. The reviewers agree with the author's conclusion that the mycorrhizal situation in plantations on new soil deserves more study on the basis of the evidence he has assembled. He has done a very definite service in reviving and developing the Stahl hypothesis. How universally it can supplant the theories of Melin and others awaits further evidence. For example water or oxygen deficiency is often limiting, with respect to which the efficiency of the different kinds of short roots need to be tested. Hatch points out that difficulty may result not only from the entire lack of mycorrhizal fungi but also from the absence of fungi adapted to the particular site or host species, and very properly calls for further study of the whole problem with reference to forestation practice. His paper is distinctly the most extensive and valuable exploration into the physiology of mycorrhizae that has appeared since Melin's 1925 work.

K. D. Doak,
Carl Hartley,
Division of Forest Pathology,
Bureau of Forest Industry,
U. S. Department of Agriculture.

The Philippine Journal of Forestry. *Vol. No. 1. 112 pp. Dept. of Agriculture and Commerce, Manila. (Quarterly.) 1938. Price $1 in United States and Philippines, $2 in other countries.*

For fifteen years, the Philippine Bureau of Forestry published *The Makiling Echo.* That mimeographed quarterly served both as a house organ for the School of Forestry and the Bureau, and as a medium for the publication of technical and scientific papers in the field of forestry.

The Bureau has now realized its long ambition to replace the *Echo* with a regular printed journal. Judging from the first issue, the new *Journal of Forestry* will be a credit to the foresters of the Philippines, and will occupy a prominent place among the growing number of technical forestry periodicals of the world. The editor-in-chief is Florencio Tamesis; the managing editor, Eduardo R. Alvarado.

W. N. Sparhawk.

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